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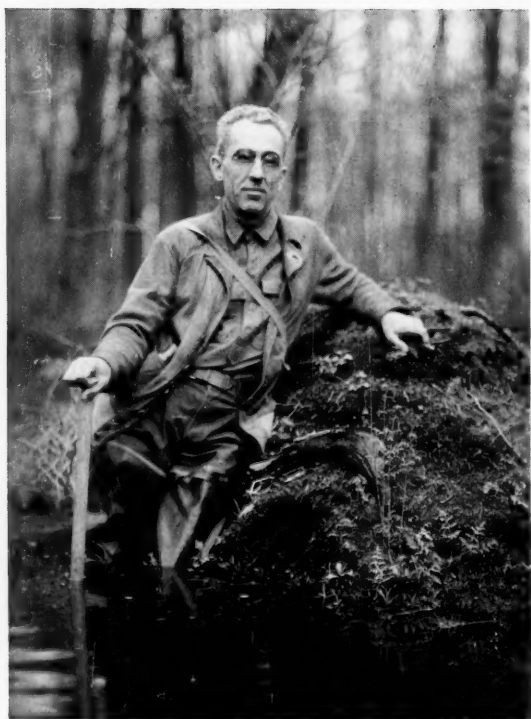
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FRANK NELSON BLANCHARD

Photographed during a salamander hunt. A nest of *Hemidactylum*, whose life history is now well known because of his researches, may be seen in the lower center of the picture.



## Frank Nelson Blanchard, 1888-1937

DR. FRANK N. BLANCHARD, stricken by bacterial infection in July, died on September twenty-first. His death was a serious loss to North American herpetology. His papers embodying research on various problems in North American snakes and on other aspects of herpetology had come to be recognized as models; his work on the life histories of snakes was especially original, and had set the standard in a field in which the genuine interest of natural history need not be lost in scientific investigation.

Frank N. Blanchard was born on December 19, 1888, at Stoneham, Massachusetts; his boyhood days were spent at nearby Somerville. Showing no inclination for the ancestral vocation of printing and publishing, his youthful enthusiasms were for music, electricity and chemistry, and it was not until he entered Tufts College that he developed the interest in biology which was to continue throughout his life. Entering as a prospective forester, he turned to zoology and to botany, through the encouragement of his professors, J. S. Kingsley and F. D. Lambert, and served as teaching assistant in the latter science during his senior year.

In 1913, after graduating at Tufts, he went to Massachusetts Agricultural College, at Amherst, to teach zoology, a position that he held for three years. Now for the first time he became actively interested in natural history. Extensive field observations were possible in a promising area, and most of the time he could spare from his academic duties was spent in the field, laying a foundation which was to aid later in making him one of the ablest natural history teachers of his day. Numerous entries in his journal<sup>1</sup> at this time show how eagerly he embraced every opportunity for zoological observations. Having lost a cherished possession on an excursion, he writes:

May 21 (Sun.) Took 9:07 car for Sunderland and went to the waterfall where I thought I lost my Phi Beta Kappa Key and found it at the very spot . . . Luckily found two earthworms in copulation under a stone, and spent over an hour making notes on the process. Got 7 new birds, making 67. Found a field sparrow's nest with 4 eggs. A most interesting day.

In 1916 he accepted a fellowship at the University of Michigan. His attention had been turning more and more toward vertebrates, and, under the inspiring influence of Dr. A. G. Ruthven, he decided upon a

<sup>1</sup> In 1905 Dr. Blanchard began the journal in which he made daily entries until his final illness. It is through the courtesy of his wife, Dr. Frieda Cobb Blanchard, his able collaborator in his field studies and in many of his researches, that the above data are made available.

study of the genus *Lampropeltis* as his doctoral problem, thus definitely centering his interest upon herpetology. In 1919, the year of the completion of his thesis, he served in the Division of Reptiles in the U. S. National Museum, a period which afforded a wonderful opportunity for stimulating association with Dr. Leonhard Stejneger. The following year, recognizing his scientific ability, the University of Michigan called him back to teach zoology; he was associate professor in this institution at the time of his death.

Wherever Dr. Blanchard might be, afield, he found problems offering themselves, and he realized that just as useful researches may be made in our own dooryards as in the alluring distance. Thus it happened that most of his researches were characteristically local, developing from problems noted on Saturday afternoon and Sunday rambles in local woods, or from field trips made for his classes. Chances for extended field work were few, but shorter trips for collecting and for observation of environments were made whenever intervals in his teaching schedule permitted.

Though his research interests had been confined to this country, he used his first sabbatical leave (1927-28) for that most desirable experience to one interested in general natural history and classification of vertebrates — a trip to New Zealand, Australia and Tasmania. When he was again eligible for leave, in the autumn of 1935, he had already made a start on a long planned manual of the snakes of the United States, a work for which he was particularly fitted through his comprehensive taxonomic studies of North American snakes and their life histories. In furtherance of this project he spent a semester, accompanied by Howard K. Gloyd, on a trip through the southwestern and western parts of the country, studying museum collections, conferring with herpetologists and making field observations. The need for such a manual and its fundamental importance are sufficiently obvious to zoologists and its completion is to be hoped for at the hands of Dr. Gloyd, who has been associated with it both in preliminary studies and final plan.

Dr. Blanchard's quiet modesty and his obviously unselfish interest in the furtherance of investigations in his field formed the basis of relations with his colleagues and students characterized always by mutual respect and confidence,—such relations as should always be distinctive of the friendships among scholars, above all, scientists.

KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

## Data on the Natural History of the Red-Bellied Snake, *Storeria occipito-maculata* (Storer), in Northern Michigan<sup>1</sup>

By FRANK N. BLANCHARD

FIELD parties from the University of Michigan Biological Station on Douglas Lake hunting snakes systematically each summer bring in relatively few of the little red-bellied snakes, *Storeria occipito-maculata*, common and wide-spread though they appear to be. It takes, therefore, numerous seasons to accumulate sufficient data on the habits of this species to justify summarizing. Most of the specimens and notes now on hand have accumulated in the seven seasons from 1930 to 1936 (although the work really began in 1925). The number of these snakes obtained in a single summer, beginning with 1930, has varied from 9 to 36 with an average of 22, and a total of 157 for the whole period.

Since no one, apparently, has heretofore made any special study of this species and but few items bearing on its habits have appeared in the literature, the topics here treated, although admittedly preliminary, should have a measure of usefulness. Even if in their present form they represent the essential truth for the species in northern Michigan, it is much to be desired that similar studies be made of this species in some other part of its range; for the suspicion has been gaining ground, with the present author at least, that many species have significant differences in details of habits and morphology in different parts of their ranges.

The area covered by these studies includes much of Cheboygan and Emmet counties and the vicinity of the now-abandoned town of Grace in the northwestern corner of Presque Isle County. Although snakes have been hunted assiduously on Hog Island (one of the Beaver Islands) and on Bois Blanc, near Cheboygan, and hundreds of snakes of other species have been found, only two specimens of the red-bellied snake have been obtained on each of these islands. Otherwise they seem to be generally distributed in this part of the state in clearings and partially wooded places.

The season for this field work has been limited to the period from the last of June to the middle of August.

The more effective work on this and other species that began with the year 1930 is directly due to aid received from the Faculty Research Fund of the University of Michigan. Each summer several students have assisted in the snake hunts, and during the past two seasons Ruth Gilreath has helped with the indoor details. Constantly the director of the Station, Professor George R. La Rue, has taken opportunity to help the work materially as well as to encourage it.

**SEX RATIO.**—Field collections over the past 12 years have netted only 25 juveniles (arbitrarily considering as immature all less than 218 mm. long; see Fig. 2). Sixteen of these were males and 9 were females (Fig. 1). Of newborn young the sex was recorded of 61. Twenty-eight of these were males and 33 were females. Summarizing these two lots of juveniles, there are 44 males and 42 females—practically a one to one sex ratio.

<sup>1</sup> Contribution from the Biological Station and the Department of Zoology, University of Michigan.

Collections of adults over the same period have provided 39 males and 71 females. In search for a cause of this marked disproportion between sexes, a table was prepared to show the dates of collection of all individuals, with their ages and sexes (Fig. 1). The collection of juveniles, it will be observed, shows no marked relation to season; and, although the number of young males does noticeably exceed that of the immature females the specimens obtained are scattered evenly through the summer. With the adults it is otherwise. From June 20 through July 16 the two sexes were obtained in equal numbers (12 males and 13 females); and from August 8 to 16 (the end of the period of the records) the sexes were found in not very different numbers—9 males and 6 females. But in the intervening time, July 17 to August 7, 53 females were collected to only 20 males. As this is too great a disproportion to be due to chance, and as the number of males was not diminished, I will suggest that it means that, when the time draws near for the birth of young, the females seek more superficial situations, where they will be better warmed by the sun, and are then more readily found. This is comparable to the habit in the females of oviparous species of seeking superficial places warmed by the sun for laying their eggs (e.g. *Diadophis punctatus edwardsii*—Blanchard, 1930: 5).

If collecting were continued throughout the season of activity of these snakes it is likely that other unequal sex ratios would appear, e.g., a larger number of males in late summer and again in early spring, related to the time of mating.

**SIZES OF COLLECTED SPECIMENS.**—The largest specimen of this species collected in the vicinity of Douglas Lake in the last 12 years was a female 325 mm. long and the smallest was 83 mm., about the average size of newborn young. Measurements of other authors fall within these limits except for a specimen 13 inches long (330 mm.) recorded by Bishop (1927: 91). By assembling in a histogram (Fig. 2) the lengths of all specimens obtained, sorted by sex, several interesting facts appear. (a) The sizes of collected specimens are largely concentrated within the limits 225 and 295 mm. (b) The largest specimens are mostly females. (c) Very few small specimens are found.

Obviously the largest specimens of each sex are mature. The range in size of adult females is easily obtained by indicating on the figure the lengths of all females bearing young. This shows that the principal group of females, comprising all individuals longer than 165 mm., is composed of an adult group, that includes most individuals 220 mm. or more in length, and a juvenile group perhaps overlapping this and extending down to individuals about 170 mm. long (Fig. 2). That these juveniles form a natural group is indicated by the concentration about the measurements 190 and 200 mm. The histogram for the males parallels that for the females in a small group centering about 190 mm. and a larger group from 220 mm. on, and it is probably fair to assume that these represent juveniles and adults, respectively, of this sex.

**LENGTH AT BIRTH.**—The length of these snakes at birth, based on measurements of over 300 specimens, varies from 67 to 98 mm., with an average length of 86 mm. These lengths (entered on the histogram of lengths of



females, Fig. 2) are consonant with those of other authors—except that Bishop (1927: 91) mentions a maximum of 3 11/16 inches—2 mm. longer than mine.

TABLE 1. VARIATIONS IN LENGTHS OF YOUNG WITHIN BROODS OF DIFFERENT NUMBERS, INCLUDING ALL COMPLETE RECORDS. MEASUREMENTS ARE IN MILLIMETERS.

Number of young in brood .....	4	5	6	7	8	9	10	11	12	13
Number of broods ....	5	4	6	6	6	1	3	1	1	1
Extremes of variation in lengths of young in broods containing the same number .....	2-8	3-7	4-9	4-11	3-14	15	5-13	7	5	6
Average variation in length among all broods of same num- ber of young .....	4.6	4.5	6.8	8.2	8.0		9.3			

No single brood, however, embraces more than half this variation of 31 mm. The least variation is 2 mm. in a brood of 4 young; the most, 15 in a brood of 9. While variation in length of young is generally related to the number in the brood, there is considerable latitude, as shown in Table 1.

TABLE 2. RECORDS FROM THE SEASON OF 1936, SHOWING RELATIVE SIMILARITY IN BIRTH LENGTHS WITHIN SINGLE BROODS, AND OBVIOUS DIFFERENCES BETWEEN DIFFERENT BROODS. MEASUREMENTS ARE IN MILLIMETERS.

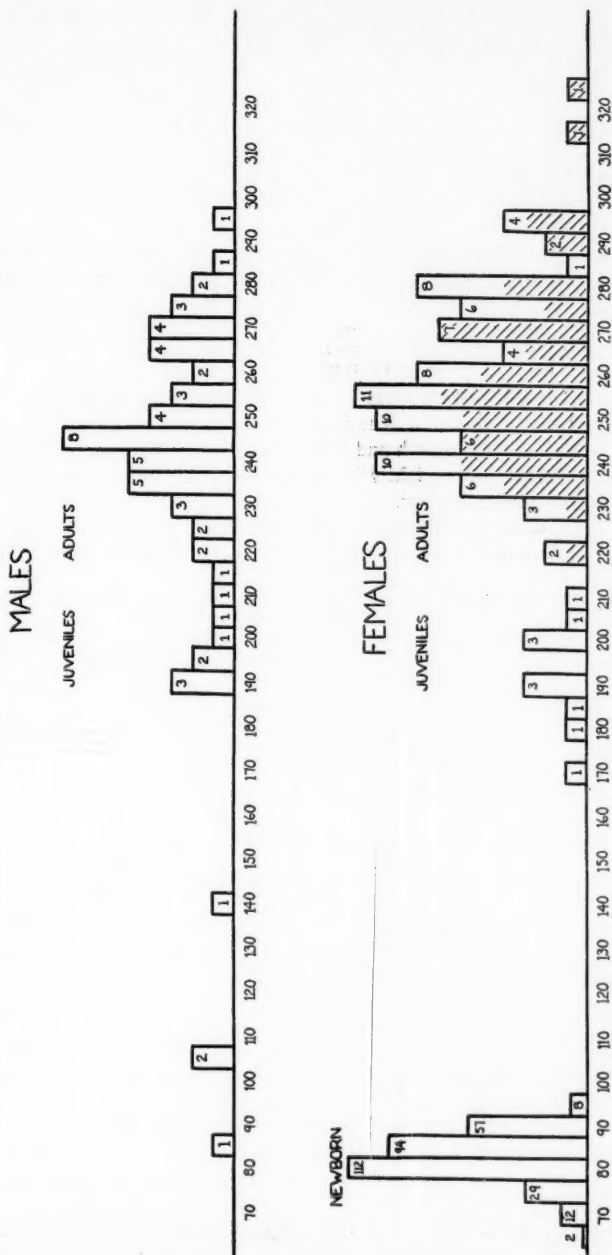
Number in brood	6	6	6	6	7
Lengths	81	89	89	92	93
of	80	86	86	92	92
young	79	84	85	90	92
	79	83	85	89	91
	77	82	85	88	91
	77	82	84	84	91
					90

In spite of this variation in size of young, the similarity within any single brood is usually notable on comparison with other broods. Typical examples of this are shown in the five broods of similar numbers in Table 2.

TABLE 3. VARIATION IN SIZE OF YOUNG WITH NUMBER IN THE BROOD FOR 9 FEMALES OF AVERAGE SIZE AND SIMILAR LENGTH. ALL MEASUREMENTS ARE IN MILLIMETERS.

Length of parent	Number of young	Average total length of young	
		In each brood	For all broods of same number
255	4	88.2	
254	4	90.5	89.4
250	6	78.8	
255	6	87.2	83.0
251	7	80.2	
253	7	90.0	85.1
252	8	89.8	89.8
250	10	81.3	
255	10	84.6	83.0

Fig. 2. Total lengths of all specimens collected at Douglas Lake and vicinity from 1925 through 1936. Females bearing young are indicated by shading. Numerals in columns show numbers of specimens in the size-classes. Mean length of newly-born young is  $85.94 \pm$  a standard deviation of 5.51 and a probable error of 0.02.





It might be supposed that, if the mothers were of the same size, the larger young snakes would be those of the smaller broods. However, the above table counters such a suggestion; and a study of 9 females of average size and similar length (250 to 255 mm.) that produced broods varying as widely as 4 and 10 (Table 3) gives scant support to this idea. Although the snakes in the broods of 4 are large, in the brood of 8 they are just as large. The young in the broods of 10 are smaller, but they are no smaller than those in the broods of 6. And the two broods of 7 vary in the sizes of their young from almost the smallest in the list to the largest.

**RATE OF GROWTH.**—The smallest specimens collected in the field were rather obviously recently born. Their lengths and dates of collection are as follows:

87 mm.	July 30, 1933	92 mm.	Aug. 15, 1931
92 mm.	Aug. 13, 1931	105 mm.	Aug. 20, 1931
107 mm.	Aug. 13, 1930	90 mm.	Aug. 22, 1930

The two largest of these can best be interpreted as born not more than several days previously. The length of the season of birth, as shown below, is ample for their growth and it is scarcely conceivable that they were a full year old and yet so slightly larger than newborn young. The smaller specimens are obviously newborn.

To facilitate consideration of the age of the other juveniles collected their lengths have been arranged against their dates of collection in Table 4.

TABLE 4. SIZES AND DATES OF COLLECTION OF INDIVIDUALS LESS THAN 218 MM. LONG AND NOT OBVIOUSLY NEWLY BORN.

Date of collection	Lengths of males	Lengths of females
June 25	141	
July 1		189
7		200
8		182
15		204
17	208	
19	195	183
20	195	183
21		189
22	200	
27	191	170
27	195	190
27		199
Aug. 1	207	
3	191	
15	191	

If it be fair to regard the scarcity of field-collected specimens of sizes between those newly born and 190 mm. as due to rapid growth at this age, then the male 141 mm. long should be interpreted as in its first spring and less than a year old—and furthermore as an early-season and rather small-sized member of the group centering about 190 mm. It would certainly do violence to our knowledge of the rate of growth of young animals to regard it as a year older than this.

Of the 19 remaining juveniles (Table 4), 13 were taken in the two-week period from July 15 to 27 and may, therefore, be assumed to represent the



variation in size of snakes of their age. If they are of the same age the variation in their length, 38 mm., is to be compared with the variation found in newborn snakes, 31 mm. This increase of 7 mm. in range of variation in length is even less than might reasonably be expected after the vicissitudes of a year. Comment on the few taken earlier and later than this period is hardly necessary. It seems logical to conclude that the snakes of both sexes collected in midsummer and measuring approximately 170 to 210 mm. are about a year old; and from the rate of growth necessitated it is evident that these snakes should breed first in their second spring, the females producing their first young at the age of two years. This conclusion is identical with that reached by Blanchard and Force (1930: 98) for the lined snake, *Tropidonotus lineatus*, and by Noble and Clausen (1936: 273) for the related species *Storeria dekayi*.

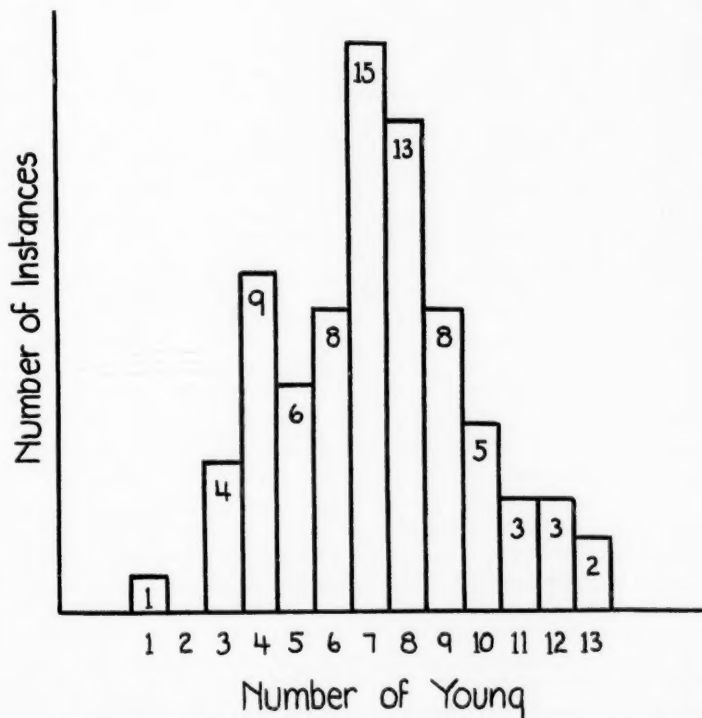


Fig. 3. Number of young at a birth. The average is  $7.18 \pm$  a standard deviation of 2.54 and a probable error of 0.20.

REPRODUCTION.—The number of young at a birth in the broods observed, was from 1 to 13 with an average of  $7.18 \pm$  a standard deviation of 2.54 and a probable error of 0.20. Thus, more than two-thirds of the broods comprised from 4 to 9 young, inclusive. Seventy-seven records obtained in the 12

seasons, including broods of 6, 8 and 9 reported by Langlois (1924: 609) in the same region in 1923, are plotted in the histogram Figure 3.

Other observers have published 20 instances of births in this species varying from 2 to 14,<sup>2</sup> with an average of 8.1 young in a brood (Table 5).

TABLE 5. NUMBERS OF YOUNG AT A BIRTH REPORTED BY OTHER AUTHORS.

Authority	Region	Number in brood	Number of records
Bishop (1927)	Allegheny State Park, New York	6	1
Bishop (1927)	Allegheny State Park, New York	9	2
Ditmars (1936)	Sullivan County, New York	6	1
Ditmars (1936)	Sullivan County, New York	7	4
Ditmars (1936)	Sullivan County, New York	8	2
Ditmars (1936)	Sullivan County, New York	9	2
Ditmars (1936)	Sullivan County, New York	13	1
Hahn (1908)	Indiana	10	1
Meyers (1924)	North Carolina	2	1
Ruthven (1906)	Isle Royale, Michigan	5	1
Ruthven (1906)	Isle Royale, Michigan	7	1
Ruthven (1906)	Isle Royale, Michigan	9	2
Weber (1928)	Adirondack Mts., New York	14	1

Although the number of records is small, when they are summarized in a table (no. 6) tendencies appear which may be significant. The average number of young increases with increase in length of the parent, but within the lengths of 235 to 260 mm. the average scarcely varies. In the larger sizes, the broods again increase, until, where records are few (over 280 mm.), it is uncertain whether this continues. The minima increase rather more steadily than the maxima. When all the figures for number of young and length of female are arranged in a correlation table, a relationship between them is visibly evident. It is not quite as close, however, as that shown for the eastern ring-neck snake (Blanchard, 1937) or for the Pacific rattlesnake (Klauber, 1936: 19) where the coefficient of linear correlation was found to be 0.61 and 0.71, respectively. In the present species it is  $0.55 \pm 0.06$ .

Ninety percent of the adult females collected in the season of embryo-bearing were pregnant.

TIME OF BIRTH OF YOUNG.—To obtain data on the time of year when the young are born, all females bearing embryos were kept in the laboratory in separate wooden cages. The earliest of fifty-seven records thus obtained is August 8 and the latest September 5. Eighty-four percent (48) of these records lie in the 14 days from August 10 to 23, the remainder (9) are scattered over the remaining 15 days. This is a close approximation to the time of birth under natural conditions, for of 17 adult females collected from August 1 to 11, in various years, 12 had unborn young, three had just given birth to their broods (as evidenced by their shrunken bodies), and 2 gave no sign of embryos or birth. Two of the shrunken specimens were taken on August 11, which corresponds with the beginning of the principal birth period

<sup>2</sup> A record of 21 young at a birth has recently been published for this species by Williams (1936: 387) for the vicinity of Cleveland, Ohio. Dr. Williams has kindly verified the record by reference to his original notes. Neither the young nor the adult were measured or preserved, but Dr. Williams has sent me his photograph of the female with 13 of her brood. A careful examination of the details of markings of the adult and young, as revealed in the photograph, force the conclusion that the species is *Storeria dekayi*.

among the captives. Furthermore, three out of four newborn young collected in the field were taken later than this date, i.e., August 13, 15 and 22.

TABLE 6. SHOWING MINIMUM, MAXIMUM AND AVERAGE NUMBER OF YOUNG BORN TO FEMALES OF DIFFERENT SIZE-CLASSES.

Size classes in mm.	Number of gravid females	Total number of young	Number of young at birth		Average number of young at birth
			Min.	Max.	
216-220	1	4	4	4	4
221-225					
226-230	1	4	4	4	4
231-235	3	13	4	5	4.3
236-240	6	36	3	11	6
241-245	7	45	3	11	6.4
246-250	4	25	4	10	6.2
251-255	10	65	4	10	6.5
256-260	4	26	5	8	6.5
261-265	3	22	7	8	7.3
266-270	4	35	7	10	8.8
271-275	6	62	6	12	10.3
276-280	4	29	6	9	7.2
281-285	1	8	8	8	8
286-290	2	17	8	9	8.5
291-295	1	5	5	5	5
296-300	2	16	7	9	8
301-305					
306-310					
311-315	1	13	13	13	13
316-320					
321-325	1	11	11	11	11
Totals	61	436	Ave. 6.1	Ave. 8.7	Ave. 7.2

Langlois (1924) reported birth dates of August 20, 21 and September 4 for females collected July 25 and August 3 and 9, respectively.

But that births in nature may sometimes antedate the earliest laboratory records is indicated by one shrunken individual taken on August 1 and another on July 27, and by a palpably newborn young one on July 30—a specimen 87 mm. long. This suggests that the keeping of pregnant females caged in the laboratory may delay the birth of the young. A tabulation of the records (Fig. 4) shows the collecting dates to be largely concentrated in midsummer. The few late births from early-collected females are about balanced by late births from late-collected individuals. We may therefore consider that the birth period is ordinarily from August 10 to 23 (as indicated by captive specimens and other data summarized above), but that young sometimes appear in late July, in late August and even in early September.

For comparison with other parts of the range of this species it may be noted that Bishop reports collecting a female with 9 embryos as late as August 22 at the Allegany State Park in New York, and two days later another female that gave birth to 9 young on September 5. From Sullivan

County, New York, Ditmars (1936: 178) records 10 broods born from August 18 to September 4. Weber (1928: 111) reports a brood from a captive female in the Adirondacks born August 29. For Isle Royale, in Lake Superior, Ruthven (1906) has recorded birth dates of September 19 and 26 from females collected September 3 and brought to Ann Arbor.

Dates of Collection of Females

		June				July				August				Totals	
		20-23	24-27	28-1	2-5	6-9	10-13	14-17	18-21	22-25	26-29	30-2	3-6	7-10	
Dates of Birth of Young	September 4-7		1							1		1			3
	September 31-3		1												1
	September 27-30								2						2
	September 23-26				1				2						3
	September 19-22	1			1				4	1	2		4		13
	September 15-18			1					3		4	1	3		12
	August 11-14						1				1			1	3
	August 7-10					1			2				1		4
Totals		1	2	1	2	1	1	0	13	2	7	2	8	1	41

Fig. 4. Diagram showing dates of collection of females and dates of birth of young of all specimens for which such data are recorded in northern Michigan.

The young at birth are nearly black above (fuscous black<sup>3</sup>) or dark brown (bone brown); below they are reddish brown (brick red or dragon's blood red); the occipital spots are pale buff, buff, or pinkish buff (cinnamon buff, pinkish buff, vinaceous-cinnamon, light vinaceous cinnamon, or cinnamon).

Details of the process of birth have been described by Langlois (1924: 609).

WANDERINGS.—Although for seven years (from 1930) all specimens collected have been individually marked (as described by Blanchard and Finster, 1933) and released on the grounds of the Biological Station, not one of them (of about 150 besides many newly born) has been recovered in a later year—a contrast with other local species. It cannot be that unfavorable local conditions are responsible for the death of all, for new specimens are occasionally found there and unmarked individuals even wander into the laboratory at times! One adult male was found near the store, where a robin was seen tugging at it.

Recoveries in the same year have been so few that they may be recounted at length. A large female released August 16, two days after her young were born, was recovered about 24 hours later, just before dark, nearly a quarter of a mile away, still within the Station's grounds. It was released after dark at the previous place of release, and was recovered again just before dark the

<sup>3</sup> Words in parentheses in this paragraph refer to the colors in Ridgway's Color Standards and Nomenclature.

next day, not quite so far away. A third time it was set at the same starting point. Three days later it was once more found at about the same distance away; and, as previously, it was just before dark. Thus, the same individual was recovered three times within five days, on each occasion several hundred feet from its starting place and wandering at the end of the day.

One other individual, an adult male, was recovered at six P.M. seven days after its release, less than 100 feet from its starting point.

Although marked snakes of this species may yet be found in a later year, failure so far shows that the recovery rate must be low, a fact chargeable, it would seem, to wandering propensities of the species, and lack of a restricted habitat and hiding places easily accessible to the collector.

Of other kinds of snakes similarly marked and released, satisfactory recoveries have been obtained of those freed in previous years—many of *Natrix sipedon*, numerous recoveries of *Thamnophis sirtalis* and *T. sauritus*, and very few of *Liopeltis vernalis* and *Lampropeltis triangulum*. The red-bellied snake is thus similar in this respect to the other terrestrial species of unrestricted habitat.

#### SUMMARY

1. Ordinarily these snakes first become parents at the age of 2 years. The minimum length of adults in northern Michigan is about 220 mm. Both sexes probably mature at about the same size, but females may grow to a greater length. The largest male measured 295 mm., the largest female 325 mm.

2. The sex ratio, ascertained from a limited number of juveniles, collected in the field and born in the laboratory, is one to one. Field collections of adults show a marked preponderance of females in the period from about July 17 to August 7. This is interpreted as a seeking on the part of the females for more superficial situations where their bodies will be warmed by the sun for the benefit of their maturing embryos.

3. Ninety percent of the adult females collected during the season of embryo-bearing were pregnant.

4. Most of the young are born about August 10 to 23, but they may appear as early as late July and as late as September 5. Thirteen records by other authors for localities in New York vary from August 18 to September 5.

5. The number of young at a birth, as shown by 77 broods, varies from 1 to 13 with an average of  $7.18 \pm$  a standard deviation of 2.54. More than two-thirds of the broods in northern Michigan, therefore, comprise from 4 to 9 young inclusive. Twenty published records for broods of this species in other localities show a variation from 2 to 14 with an average of 8.1. This difference is interpreted as indicating, possibly, a significant geographical variation in this feature.

6. The range of variation in length at birth is 67 to 98 mm. although no single brood shows a variation of more than half this number. The average length of young is 85.94 mm. Members of the same brood are generally rather uniform in size. Different broods may vary markedly in the sizes of their component individuals, but such sizes do not seem to be correlated with the number in the brood.

7. The average number of young at a birth appears to increase with the length of the female, with the exception that within the lengths 235 to 260

mm. the average scarcely varies and there are so few records of the larger snakes that it is uncertain how far this relation continues. Treating all the records for length of female and number of young as a linear relationship, the coefficient of correlation is found to be  $0.55 \pm 0.06$ .

8. Although, beginning with 1930, all specimens obtained have been individually marked and released, there have been no recoveries in a later year, in contrast with other species of snakes studied at the same time. The few retaken in the same season have been found within one to seven days after their release, traveling shortly before dark, and, except in one instance, several hundred feet from the point of release.

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## The Amphibian and Reptilian Fauna of Bromeliads in Costa Rica and Panama<sup>1</sup>

By EMMETT REID DUNN

I here attempt to combine the data on the vertebrate fauna of the bromeliad habitat niche in Lower Central America in Picado's "Les Broméliacées épiphytes considérées comme un milieu biologique" (Bull. Sci. France Belg., (7) 5, 1913: 215-360, pl. 6-24, 54 text figs.), with data I have gathered myself.

### CAUDATA

#### *Oedipus picadoi* Stejneger

Picado's figure (pl. 8, fig. 4) represents the type (U.S.N.M. No. 48280), which Picado took from a bromeliad at La Estrella in September. Prof. Manuel Valerio has taken it from a bromeliad at 2200 m. on Escazu. It is not confined to bromeliads.

#### *Oedipus subpalmatus* (Boulenger)

I have taken this species from bromeliads on Carpintera, Tablazo, and Barba, and on the ground under logs on Poas.

#### *Oedipus lignicolor* (Peters)

I have taken this form in bromeliads and climbing on vines, at Boquete.

### SALIENTIA

#### *Eleutherodactylus caryophyllaceus* (Barbour)

Not restricted to bromeliads, but I have found it in them at La Hondura.

#### *Eleutherodactylus diastema* (Cope)

I have taken a male with a clutch of 11 eggs in a bromeliad on top of Tablazo. It is not confined to the plants.

#### *Eleutherodactylus melanostictus* (Cope)

I have not found this species in bromeliads. Picado's fig. 5, pl. 12, referred to "*Hyla phacota*," resembles this species and is certainly not *Hyla phacota*.

#### *Eleutherodactylus* species

Picado's *Eleutherodactylus brocchi* (p. 342, pl. 8, f. 3) is unidentifiable. *E. brocchi* does not occur in Costa Rica. Picado's material is from bromeliads at Palomo, 1300 m.; Orosi, 1200 m.; La Mica; and La Estrella. Three from La Mica were U.S.N.M. Nos. 48281-3, but are now lost.

#### *Hyla zeteki* Gaige

See extended account below. This is certainly the *Hylella fleischmanni* of Picado, p. 242, pl. 12, f. 2 (the specimen from La Estrella is U.S.N.M. No. 48727). "*Eleutherodactylus diastema*" of Picado, p. 242, pl. 12, f. 3, is probably also this species. A second specimen from La Estrella, which was U.S.N.M. No. 48728, is now lost.

#### *Hyla picadoi*, sp. nov.

TYPE.—M.C.Z. No. 16002, collected by E. R. Dunn and Manuel Valerio, January, 1929, Volcan Barba, Costa Rica, a little above the farm of Manuel Acosta, 2140 m.

<sup>1</sup> Contributions from the Department of Biology, Haverford College, No. 32.



RANGE.—Known only from type locality and from El Gallito (east end of Barba, 1900 m.).

DIAGNOSIS.—Very similar to *Hyla zeteki* but larger; tympanum completely concealed by a parotoid gland; upper lip notched; lower jaw with two pseudo-teeth.

DESCRIPTION.—The type is an adult male, 32 mm. long (male *zeteki* 23 mm.); adult female 33 mm. (female *zeteki* 27 mm.); fingers with rudimentary webs at base; toes  $1/3$  webbed, first toe free; head and body depressed; snout blunt; eyes set anteriorly; vomerine teeth in two small groups behind level of choanae; tan, with a dorsolateral dark line from snout to vent.

REMARKS.—Five specimens are known, four in the original series (two in my own collection, the type, and Mus. Zool. Univ. Mich. No. 70179), and one from El Gallito (in my collection). All were taken from bromeliads. I name this species for my friend Dr. Picado, in recognition of his work on the bromeliad fauna of Costa Rica, and in the hope that he may be able to obtain some information on its breeding habits. I had been considering this form as the adult of *zeteki* until I got the latter at La Hondura.

*Hyla pseudopuma* Günther

This *Hyla* is common in bromeliads at La Hondura and on Barba. It is not confined to them and almost certainly does not breed in them. This is in part (p. 342 in part, pl. 12, f. 4) Picado's "*Hyla phaeota*." Specimens sent by him from La Estrella are U.S.N.M. Nos. 48725-6.

*Gastrotheca coronata* Stejneger

The type, taken by Picado from a bromeliad at Palomo, 1200 m. (U.S. N.M. No. 48729) is still the only Central American specimen of the genus.

SERPENTES

*Sibon sibon* (Linnaeus)

I have taken this species in a bromeliad at Guapiles.

*Imantodes cenchoa* (Linnaeus)

This species was taken from bromeliads at Navarro, Zent, and Suretka.

*Leptodeira annulata annulata* (Linnaeus)

My friend, Ferdinand Nevermann, presented me with one large and two small specimens of this species taken from a single plant at Salvadora Farm on the Parismina River.

EGGS AND TADPOLES OF *Hyla zeteki* GAIGE

On June 7, 1936, Mrs. Dunn and I, in the company of Mr. Ferdinand Nevermann, were so fortunate as to discover eggs, tadpoles, and adults of a bromeliad breeding *Hyla*. They were found on the finca of Felix Delgado, at about 1280 meters above sea-level, between La Palma and La Hondura, Costa Rica.

The species in question seems to be *Hyla zeteki* Gaige (Occ. Pap. Mus. Zool., Univ. Mich., 207, 1929: 4), type M.Z.U.M. No. 63875, described from thirteen specimens taken from bromeliads. The type came from the Caldera



Valley above Boquete, Chiriqui, Panamá, between 3800 and 4500 feet altitude. It was 27 mm. long, and our specimens have been compared with it. The only difference is that the original description mentions a slender red vertebral stripe, and a "narrow spectacle-like mark around each eye, joining across the snout," the latter "lacking in some." These red marks were not apparent in ours. U.S.N.M. No. 48727 from La Estrella, Costa Rica, "2000 meters" (probably not so high) also appears to be the same species. This specimen is figured and mentioned as "*Hylella fleischmanni*" in Picado's monograph of 1913 (p. 242, pl. 12, f. 2). It also was taken from a bromeliad.

Our five frogs, nine tadpoles, and five eggs were taken from eleven plants, nine of which were on the same fallen tree, while two were on separate standing trees not very far away (within 25 yards). Three plants contained each a single tadpole; two contained each a single frog; one (from a standing tree) contained a tadpole and a frog; one (from a standing tree) contained two tadpoles (one large, one small); one contained two frogs; one contained two eggs; one contained three eggs; and one contained three tadpoles.

The eggs were on the outside of the leaves, above water level. Two were together, on the same leaf; three in another plant were on three separate leaves. The tadpoles were between the leaves, in water; not in the central core of the bromeliad. The water in bromeliads containing eggs or tadpoles did not differ perceptibly from that in other bromeliads.

The eggs were in different stages of development. In one the central mass was still spherical, measuring about 1 mm. in diameter. The others all showed some stage of tadpole development up to fairly well differentiated head-body and tail. The egg with capsule measures about 2.5 mm. in diameter. Only one capsule can be made out in the material.

The nine tadpoles fall roughly into four size groups:

1. head-body 4 mm., tail 9, no sign of hind limbs. One specimen.
2. head-body 6 mm., tail 12, hind limb buds. One specimen.
3. head-body 8-9 mm., tail 14-15, legs well developed, feet not well developed. Four specimens.
4. head-body 10 mm., tail 18, legs and feet well developed. Three specimens. These are probably quite near transformation as the arms, while still under the spiracular cover, are well developed, the finger disks showing plainly.

It would seem that the relative length of the tail decreased with age. These tadpoles have: sinistral spiracle; dextral anus; no dorsal fin on body; a dermal fold separating tail from body, this sometimes absent on middorsal line; tail fin low, everywhere the same width; tail length 2.25-1.8 times that of head body, longest in smallest specimens; head-body flattened dorso-ventrally; mouth opening largely dorsal, capable of great distention, upper lip shorter than under; labial teeth very few and sparsely placed, a single row on upper lip, a similar row on under lip, with an irregular and even more widely spaced row posterior to it; pigmentation of evenly spaced and relatively few melanophores above; fewer and more irregularly spaced below; pale gray with no markings, the white muscles and the color of viscera and food completely predominating over the pigmentation; nostrils situated on

prominences, about as far apart as eyes, slightly nearer to eyes than to each other; jaws well developed; stomach enormous (capacity in a specimen of 9 mm. head-body length more than 16 cu. mm. since it contained at least 31 eggs of its own species); intestine not coiled, extremely short, about half total length (coiled and three times total length in tadpole of *Hyla sordida*, which may represent the normal hylid tadpole), muscles of jaw region enormously developed as compared with *Hyla sordida*; *subhyoideus* approximately four times the area in cross-section; *orbitohyoideus* short and thick (thin and strap-like in *Hyla sordida*); no distinction whatever between *subangularis* and *ceratohyoideus-angularis*, a single short thick muscle present (in *Hyla sordida* two small muscles having nearly the same origin but different insertions); *adductor mandibularis* short and thick, undivided (in *Hyla sordida* elongate, divided anteriorly, with two insertions); other muscles of head and body feeble; gill arches without filaments; lungs large (nearly to end of body cavity in specimens of 10 mm. head-body length; lungs simple, unpigmented, thin-walled sacs without alveoli.

The stomachs contained no recognizable food save eggs of their own species.

The facts reported above may, perhaps, warrant the following tentative inferences. The observed disposition of the five eggs may indicate that *Hyla zeteki* lays its eggs out of water and moves about during oviposition. The stomach contents of the tadpoles may indicate that eggs of its own species furnish the major source of food supply for the tadpole; the peculiarities of mouth parts, jaw muscles and digestive tract may reflect peculiarities of the feeding habits and the food; the reduction of gill filaments may indicate a difference in respiration from more normal hylid tadpoles; the reduction of fin and the progressive reduction of tail length may reflect the confined nature of the swimming space.

Heavy rains occurred daily during our stay at La Hondura. It rained steadily and hard every afternoon. On one night we were able to get out a bit between rains, and on one night after a very heavy rain we were able to get out for several hours.

There are a number of interesting parallels and differences between the tadpoles of *Hyla zeteki* and those of the four Jamaican hylas which I took from bromeliads in 1925. (Dunn, Proc. Boston Soc. Nat. Hist., 38, 1926: 111-130; Noble, Bull. Amer. Mus. Nat. Hist. 58, 1929: 291-333. Some statements as to field conditions in the latter paper, which differ from the former, are to be disregarded, as they are erroneous, and based on no personal knowledge.)

*Hyla zeteki* is related on the one hand to a number of small Central American hylas which have reduced finger webbing and the vomerine teeth placed posterior to the nares. This is the so-called "*Hyla punctariola*" group, even though the typical form of it is an *Eleutherodactylus*. On the other hand it is related through the species described above to *Hyla glandulosa* of Guatemala.

The Jamaican hylas are obviously related through *Hyla brunnea* to the very similar Cuban *septentrionalis* and Hispaniolan *dominicensis*. These belong to the so-called "*Hyla trachycephala*" group, whose only mainland

representative, the typical form, inhabits Venezuela. There is no question that the adults of the Costa Rican and the Jamaican forms are only remotely related to each other, and that any similarities of the tadpoles have been independently acquired.

The Jamaican hylas lay eggs in masses in water in the center of the plants, whereas *zeteki* lays its eggs singly, above water level, on the outsides of the leaves.

The Jamaican tadpoles live in the central core of the plant, a space large enough to accommodate a human fist, in a glycerine-like fluid resulting from a mixture of rain water and degenerating egg capsules, whereas *zeteki* tadpoles live in the more confined spaces between the leaves, in unmodified rain water.

In body form *zeteki* tadpoles are much flatter than the Jamaican ones, but the latter have much longer tails. Possible correlations may be seen here with the confined space in which *zeteki* lives, and with the viscosity of the medium in which the Jamaican tadpoles live (the froth nest tadpoles of *Leptodactylus* and *Engystomops* have very long tails).

Neither the tadpoles of *zeteki* nor of the Jamaican forms have dorsal fins on the body, a reduction which I pointed out years ago was the rule in amphibian larvae which live in running water, but it is obvious that this correlation does not hold here, and I have no suggestion to offer.

In spite of the difference in the fluid medium in which they live, both lots of tadpoles have an extraordinary degeneration of gills, gill filaments and gill musculature.

The reduction of the dentition, the great extent of the mouth opening, the increased size of the jaw muscles, the increased size of the stomach and the reduction in the length of the intestine, in all of which the Costa Rican and Jamaican tadpoles agree, may be correlated with the diet. I cannot resist the supposition that in both cases actual cannibalism (eating of other tadpoles) takes place, but there is, as yet, no proof of this.

While it is remarkable that so many parallel modifications occur in these tadpoles from Jamaica and Costa Rica, it is equally remarkable that bromeliad tadpoles of *Hyla bromeliacea* in Honduras (Schmidt, Zool. Series Field Mus. Nat. Hist., 20, 1933: 19) should show no such modifications, and that brevipitid tadpoles from East Africa (Barbour and Loveridge, Mem. Mus. Comp. Zool., 50, 1928: 256; Noble, *l.c.*; Loveridge, Bull. Mus. Comp. Zool., 74, 1933: 414-5) found in internodes of bamboos and between leaves and stems of banana plants, should, in many ways, including powerful jaw muscles, diet, and gill reduction, show modifications like those of Jamaican and Costa Rican hyliid tadpoles.

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Some Results of Trout Tagging in Massachusetts<sup>1</sup>

BY ROBERT A. NESBIT AND J. ARTHUR KITSON

## INTRODUCTION

IT IS generally recognized that satisfactory angling conditions can be maintained in the intensively fished trout streams of our populous Atlantic seaboard states only by heavy and frequent stocking with trout of legal size. There is, however, disagreement as to whether it is more advantageous to distribute them in the autumn or to hold them over in hatcheries until the following spring.

If fish are planted in the autumn preceding the fishing season during which most of them are destined to be caught, it is obvious that the cost of caring for them over winter is avoided. Many anglers favor fall planting because they believe that fish which have lived under natural conditions for several months before the opening of the season are gamier and of better flavor and color.

On the other hand, many conservation officials are convinced that the over-winter losses among fall planted trout are so great as to render the survivors extremely expensive fish. The present experiment was designed to determine whether the interests of anglers are best served by spring or by fall distribution.

## PROCEDURE

The method of internal tagging described by Nesbit (1934) was used. The tags were numbered and printed strips of bright yellow, soft rubber,  $1\frac{1}{4}$ " long by  $\frac{1}{4}$ " wide and about  $\frac{1}{32}$ " in thickness. A preliminary experiment was carried out at the Montague State Fish Hatchery with 400 rainbow trout, ranging from six to nine inches in length. Several shapes and sizes of celluloid belly tags were used. The mortality was negligible (less than 2%). However, the experiment disclosed a serious and hitherto unsuspected defect in the method of internal tagging when applied to trout. At the end of a month it was observed that a number of tags were being lost through a new opening on the side of the body opposite from the incision through which the tags had been inserted.<sup>2</sup> This phenomenon has not been observed with other species. In the hope of avoiding this difficulty soft rubber tags were ordered, but they proved to be even less satisfactory than celluloid, for not only were they lost as readily but the chrome yellow pigment was toxic enough to cause considerable mortality during the first two weeks after tagging. For such experiments in the future, a better tagging method should be used. The jaw method described by Shetter (1936, 1937) appears to be the best yet devised for trout.

Between October 15 and October 19, 1934, there were tagged 2,887 rainbow trout of 6 to 10 inches in length and 4,830 brown trout of the same size range. They were divided into ten lots for distribution as indicated in Table I. All were held under observation until late November, 1934, when those designated for fall distribution were planted. The lots designated for

<sup>1</sup> Publication authorized by the United States Commissioner of Fisheries and the Massachusetts Commissioner of Conservation. Printed under the grant of the American Wildlife Institute for the publication of biological contributions fundamental to fish management.

<sup>2</sup> Similar losses of the internal tags were experienced in Michigan (see discussion by Shetter on p. 319 of *Trans. Am. Fish. Soc.*, 66, 1937).

## TROUT TAGGING

TABLE I. TROUT TAGGED AND RECAPTURED IN THE 1934-35 EXPERIMENTS  
OF THE MASSACHUSETTS DIVISION OF FISHERIES AND GAME.

Experiment	Tagged Number	Losses		Released Number	Released, Recaptured Number	Recaptured %	Ratio of % Spring to Fall Recaptures
		Died	Tags Lost				
Rainbow trout:							
Millers River, Spring planting	918	90	176	652	97	14.9	9.9 to 1
Millers River, Fall planting	978	59	6	913	10	1.5	
Onota Lake, Spring planting	494	81	129	284	26	9.2	2.1 to 1
Onota Lake, Fall planting	497	32	1	464	14	4.3	
Brown trout:							
Westfield River, Spring planting	937	225	113	599	70	11.7	5.1 to 1
Westfield River, Fall planting	933	253	4	676	13	2.3	
Farmington River, Spring planting	985	253	127	605	55	9.1	2.9 to 1
Farmington River, Fall planting	985	266	..	719	589	18	
Big Spectacle Pond, Spring planting	491	143	32	316	7	2.2	2.0 to 1
Big Spectacle Pond, Fall planting	499	173	..	326	3	1.1	
Rainbow and Brown trout:							
Rivers, Spring planting	2,840	568	416	1,856	222	12.0	5.2 to 1
Rivers, Fall planting	2,896	578	10	2,308	41	2.3	
Ponds, Spring planting	985	224	161	600	33	5.5	1.9 to 1
Ponds, Fall planting	996	205	1	790	595	17	

spring distribution were planted during the last week in March and the first week in April, 1935. The trout season opened April 15.

Considerable mortality occurred during the first two weeks due to the unfortunate choice of the rubber colored with a toxic pigment. In addition, many fish were lost to the experiment because the tags worked out through the body wall. The experiment was conducted so that the only differences between the lots planted in the fall and those held over until spring are the dates of release. Since all the fish were tagged in the same manner and at the same time, losses due to the defects in the tagging method may be disregarded for purposes of comparison. For the spring planting, the percentages of fish recaptured are based on the numbers of fish released and known to be bearing tags. For the fall planting, the percentages are based on the numbers of fish known to be bearing tags when released, less the percentage loss observed to occur during the winter among the tagged fish held for spring planting. Since normal mortality among fish of this size is insignificant in well managed hatcheries, it was assumed that all losses among the latter lots were due to the tags and that similar losses would be expected to occur among the tagged fish released in the autumn.

#### RESULTS

It will be noted in Table I that in no experiment was the percentage recaptured from fall-planted fish as high as from spring-planted fish. The differences were less marked in the two ponds than in the rivers. Three tags were recovered from the stomachs of pickerel taken in winter from Onota Lake, Pittsfield.

Considering the three rivers, it will be noted that the differences in the percentage recaptured ranged from approximately 10 to 1 for rainbow trout in the Millers River, and that the average for all three streams was approximately 5 to 1. These observations indicate that if fish are planted in the autumn the over-winter losses are so great that five times as many fish are required to provide a given catch as are needed if the fish are held in the hatchery until spring; or that a given number of spring-planted fish can be expected to yield five times as much angler satisfaction as the same number of fall-planted fish. Against these advantages must be weighed, of course, the additional cost of holding fish in the hatchery over winter and the less readily evaluated considerations of increased gaminess and better quality.

It is estimated that the additional cost of carrying trout of the sizes used in the experiment from December 1 to April 1 would be approximately 2.5 cents per fish, an increase of about 50 per cent in the cost. But since the number of surviving fish is so much augmented, the cost per fish caught by sportsmen is actually materially reduced—by far the best criterion of the efficiency of a stocking policy. The greater efficiency of spring planting is illustrated by the following example.

If it costs 5 cents per fish to rear a trout to an average length of eight inches on December 1, the additional cost of holding it until April 1 will be about 7.5 cents. If 35 per cent are taken by anglers, the cost per fish in the creel is 21.2 cents. If they be planted in the fall, on the other hand, the cost per fish planted is about 5 cents, but since only 7 per cent will be taken by sportsmen, the cost per fish in the creel will be 71.5 cents per fish.

The estimate of the percentage of spring-planted trout taken by anglers is based on the Connecticut experiment reported by Cobb (1934). In that



experiment, returns were much higher than in the present study, doubtless because the fish were released immediately after tagging, many of them after the season opened, and did not have time to lose their tags. Although the returns from spring planting in the present experiment cannot be considered as indicating the percentage of planted trout actually caught, the differences between the percentages of spring and fall-planted trout recaptured may be regarded as reliable, for reasons set forth above.

The data of the present experiment do not indicate whether fall planted trout are, as many anglers believe, of better flavor and color than spring planted fish. In future experiments it would be of interest to determine whether anglers are able to distinguish between the two by asking them to state an opinion concerning each fish caught.

TABLE II. COMPARISON OF GROWTH INCREMENTS OF SPRING-PLANTED AND FALL-PLANTED TROUT

Experiment	Number	Average length when tagged	Average length when caught	Gain	Ratio gain spring to gain fall
		Inches	Inches	Inches	
Rainbow trout:					
Spring planting:					
Millers River .....	88	7.7	10.4	2.7	
Onota Lake .....	25	7.8	11.0	3.2	
Total .....	113	7.8	10.6	2.8	
Fall planting:					1.8 to 1
Millers River .....	9	7.9	9.6	1.7	
Onota Lake .....	14	8.0	9.6	1.6	
Total .....	23	8.0	9.6	1.6	
Brown trout:					
Spring planting:					
Westfield River .....	58	8.4	9.9	1.5	
Farmington River .....	38	8.2	9.9	1.7	
Big Spectacle Pond .....	2	9.0	10.7	1.7	
Total .....	98	8.4	10.0	1.6	
Fall planting:					1.8 to 1
Westfield River .....	12	8.0	8.7	.7	
Farmington River .....	9	9.1	10.0	.9	
Big Spectacle Pond .....	2	8.3	10.0	1.7	
Total .....	23	8.4	9.3	.9	

Not only does a policy of spring planting give anglers more fish for a given cost, but in one important respect, it gives them better, i.e., larger, fish, since fish held over winter in the hatchery grow faster than those planted in the streams in autumn. This is shown by Table II, in which the growth increments of spring-planted and fall-planted fish are compared. The data are based on measurements made when the fish were tagged and on anglers' reports on the lengths of the fish when caught. Doubtless the size superiority of the spring-planted fish (about one inch), more than compensates for the alleged laziness of recently planted trout.

As a consequence of the findings on this study, the Massachusetts Division of Fisheries and Game has adopted the practice of holding over as many trout as the capacity of the hatcheries permits, retaining them through the winter until spring. It is perhaps significant that anglers have generally expressed the opinion that fishing was better in Massachusetts during the 1937 season than in previous years when trout were planted in the fall.

The results of this experiment may not be of general application. Doubt-

less conditions affecting over-winter mortality differ greatly in different streams. Hence, similar experiments will be required to determine the best policy for each set of conditions encountered.

#### SUMMARY

To determine whether it is more advantageous to plant trout in the autumn or to hold them in rearing ponds until the following spring, several thousand rainbow and brown trout were tagged and released in two lots in Massachusetts rivers and ponds, one lot in the fall, the other the following spring. It is estimated from the returns that for a given cost, anglers can be given more and larger fish if trout of legal size are held over winter in hatcheries and planted just before the opening of the season. It was also found, incidentally, that the internal tagging method is unsatisfactory on trout.

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### Melanin Dispersion and Choice of Background in Fishes, with Special Reference to *Ericymba buccata*

By FRANK A. BROWN, JR. and DAVID H. THOMPSON

IN VIEW of the tendency of fishes to change their skin color to resemble their background, it occurred to us that it would be desirable to learn whether or not fishes select backgrounds to correspond to their skin color. The adaptation of skin color to background is accomplished ordinarily within the course of a very few minutes by dispersion or concentration of the pigment granules within the pigment cells of the skin. This response is governed by the relative amounts of incident and reflected light reaching the eyes (Sumner and Keys 1929, Sumner 1933, Brown 1936, Parker, Brown and Odiorne 1935). In spite of the many interesting aspects of such experiments, we are aware of only two experiments of this nature having been performed with fishes (Sumner 1911 and Mast 1916). Sumner, on the basis of a few brief experiments, concluded that certain flatfishes did not exercise an adaptive background selection, whereas Mast a few years later, after somewhat more extensive experimentation, concluded that flatfishes did exercise such selection.



The experiments to be described record several thousand choices of individual background-adapted fishes. They demonstrate conclusively that fishes are influenced in their choice by the background to which their skin is adapted.

#### EQUIPMENT AND METHODS

The equipment (see Figure 1) used in these experiments consisted of a large shallow pan 42 x 45 x 5 cm., half the inside of which was painted with flat black paint, the other half painted white. This pan will be referred to as the *choice pan*. Set inside of the choice pan was a second pan (*A* in the diagram) of the odd shape and of the dimensions indicated in the figure. This latter pan will be referred to as the *adaptation pan*. It was also 5 cm. deep. The narrow open chute of the pan was 2 cm. in width. There were two pans of this second type, one whose interior was painted black, and the other white. Thus, with this equipment a fish could be placed in one of these adaptation pans and its choice of background determined as it emerged. In order to reduce the subjective aspect of the statement of choice as much as possible, two light lines were drawn upon the bottom of the choice pan parallel with the junction of the black and white halves. A fish was said to have made a selection when one eye had crossed the line upon one side or the other.

It was originally planned to place several fish in the adaptation pan at once and thus speed up the process of collection of data, but a few initial experiments showed clearly that the gregarious nature of the fishes used was such that the first fish out would generally determine the choice of the ones following. Consequently, in all the experiments only one fish was placed in the apparatus at a time. A small dip-net was used to place the fishes in either the black or the white adaptation pan from other black or white vessels, depending on the nature of the experiment.

The paint used on the pans and other equipment was allowed to dry thoroughly and season under water before the experiments were begun. The experiments reported here were all carried out between 15° C and 22° C. Another short series of experiments with the silver-mouthed minnow showed no appreciable effect of temperature on choice over, the range 10° C to 30° C. The water used was the so-called "biological water" of the University of Illinois. This water is the ordinary tap water which has been run through an activated charcoal filter to reduce the chlorine and chloramine content. Before use this water was aerated. Light was furnished by a 50-watt frosted incandescent lamp centered one foot above the choice pan, and supplemented by diffused daylight from a high window which brought the total illumination of the pan to between 50 and 65 foot candles. Every attempt

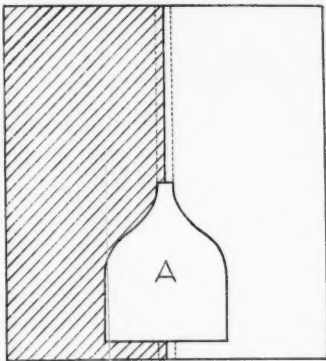


Figure 1. A diagram of the apparatus used to measure background choices in fishes. *A* is one of the adaptation pans from which fishes emerged to choose either black (the cross-hatched portion) or white (the clear portion) of the larger choice pan.

was made to obtain symmetrical sources of illumination with respect to the junction of the white and black halves of the choice pan. The water in the pan was 3 cm. deep.

The fishes were taken in minnow seines from three dredge ditches in the vicinity of Urbana. The water in these ditches varies from a few inches to about three feet in depth and is more or less turbid at all times. The fishes were kept alive, without feeding, in large tanks in a cool, dimly-lighted room for various periods up to a month before being used. The experiments were carried on during the period December, 1936 to March, 1937. Since the collections were mixed lots, the experiments on each of the species used were scattered throughout this period.

#### BACKGROUND CHOICE OF BACKGROUND-ADAPTED FISHES

Background choice has been determined for black- and white-adapted fishes of the following species: silver-mouthed minnow, *Ericymba buccata* Cope; blunt-nosed minnow, *Hyborhynchus notatus* (Rafinesque); steel-colored minnow, *Notropis whipplii* (Girard); straw-colored minnow, *Notropis deliciosus* Girard; horned dace, *Semotilus atromaculatus* (Mitchill); dough-belly, *Camptostoma anomalum* (Agassiz); blackfin, *Notropis umbratilus* (Copeland); orange-spotted sunfish, *Allotis humilis* (Girard).

TABLE I

Experiment Number	SILVER-MOUTHED MINNOW		BLUNT-NOSED MINNOW	
	Black adapted		Black adapted	
	Choice	White	Choice	White
	Bl.	Wh.	Bl.	Wh.
I .....	46	4	25	25
II .....	41	9	22	28
III .....	42	8	13	37
IV .....	40	10	19	31
V .....	45	5	15	35
VI .....	49	1	34	16
VII .....	48	2	25	25
VIII .....	37	13	18	32
Total .....	348	52	171	229
Percent ...	87	13	43	57

Fishes that had remained upon black or white backgrounds for times ranging from ten minutes to a few hours were placed in the adaptation pan of the same color and their background choices observed as they emerged. Considering that several collections of minnows were used during these experiments, which were carried out over a period of about three months, the results obtained at different times seem remarkably consistent.

In order to make the results from black- and white-adapted fish comparable, the same individuals (from 3 to 10 fish in a lot) were run through the apparatus one hundred times in each experiment—fifty times from a black background and fifty from a white background. Each such experiment was completed within 3 hours. In some experiments the fish were adapted to white first while in others the order was reversed. The data from eight such experiments of 100 trials each on six species of minnows are summarized in Tables I, II, and III. Somewhat shorter series of data of the same kind for another minnow and the orange-spotted sunfish are shown in Table IV.

TABLE II

Experiment Number	STEEL-COLORED		MINNOW		STRAW-COLORED		MINNOW	
	Black adapted		White adapted		Black adapted		White adapted	
	Choice		Choice		Choice		Choice	
	Bl.	Wh.	Bl.	Wh.	Bl.	Wh.	Bl.	Wh.
I .....	46	4	31	19	44	6	13	37
II .....	37	13	27	23	32	18	13	37
III .....	42	8	31	19	45	5	18	32
IV .....	37	13	25	25	45	5	21	29
V .....	43	7	34	16	42	8	27	23
VI .....	47	3	33	17	40	10	20	30
VII .....	41	9	22	28	27	23	4	46
VIII .....	46	4	15	35	31	19	6	44
Total .....	339	61	218	182	306	94	122	278
Percent ...	85	15	54	46	76	24	30	70

TABLE III

Experiment Number	HORNED DACE		DOUGHBELLY	
	Black adapted		Black adapted	
	Choice		Choice	
	Bl.	Wh.	Bl.	Wh.
I .....	37	13	34	16
II .....	44	6	33	17
III .....	47	3	31	19
IV .....	48	2	33	17
V .....	42	8	36	14
VI .....	43	7	33	17
VII .....	45	5	21	29
VIII .....	45	5	30	20
Total .....	351	49	251	149
Percent ...	88	12	63	37

TABLE IV

Experiment Number	BLACKFIN		ORANGE-SPOTTED		SUNFISH	
	Black adapted		Black adapted		White adapted	
	Choice		Choice		Choice	
	Bl.	Wh.	Bl.	Wh.	Bl.	Wh.
I .....	37	13	19	31	45	5
II .....	9	1	1	9	39	11
III .....	..	..	..	..	43	7
IV .....	..	..	..	..	45	5
V .....	..	..	..	..	25	5
Total .....	46	14	20	40	197	33
Percent ...	77	23	33	67	86	14

Comparison of the ratios of choice in different experiments on the same fish show only a little more variation than would be expected from random sampling. The results on the silver-mouthed minnow, the steel-colored minnow, and the horned dace are relatively consistent while those from the blunt-nosed minnow and the straw-colored minnow are somewhat more irregular. Although no attempt has been made to calculate the statistical significance of these percentages, we feel confident that, inasmuch as each percentage of choice is based on 400 trials taken from various collections over a three-month period, they are repeatable within a few percent. The errors of the percentages

shown in Table IV are probably somewhat larger since they are based on smaller numbers of trials.

The background choices of black- and white-adapted fish of each of the eight species shown in Tables I to IV are represented graphically in Figure 2.

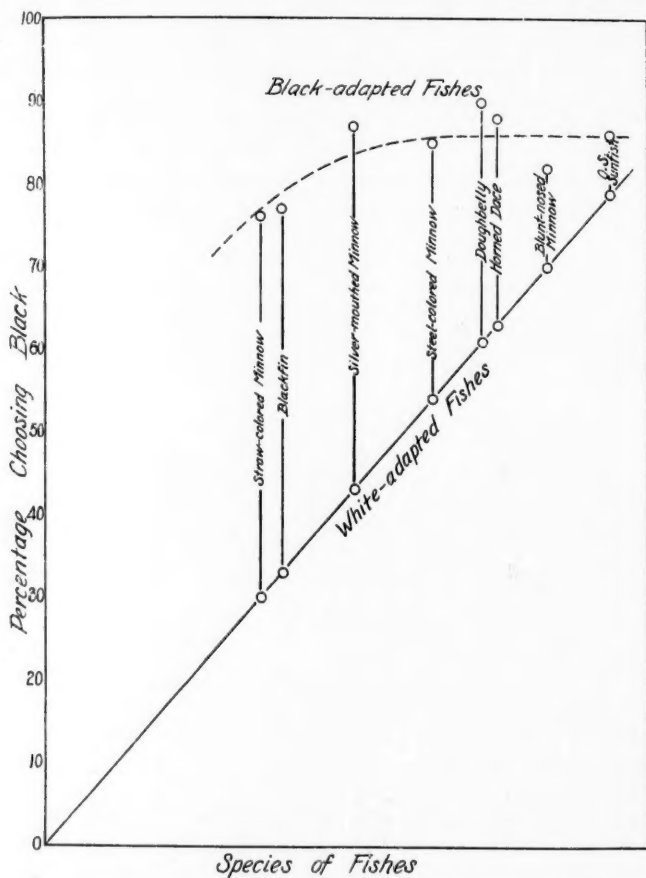


Figure 2. The percentage choice of black in each of eight species of fishes adapted to black and white backgrounds. For convenience the choices of white-adapted fishes have been arranged on a diagonal.

For purposes of comparison all choices are shown as the percentage of fishes choosing the black background regardless of whether they were black-adapted or white-adapted. The point for each of the eight species representing the percentage choosing black after having been on a white background is placed on a diagonal line drawn through the origin. When this is done the points representing the opposite-adapted fishes of the eight species are grouped

somewhat more regularly than if the black-adapted points had been placed on a diagonal.

The obvious conclusion to be drawn from this chart is that the differences in percentage of choice of black-adapted fishes among these species are comparatively small. The differences are much more distinctive among white-adapted fishes of these species. All eight species show percentages choosing black, after having been black adapted, between 76 and 90 percent. On the other hand, these eight species choose black, after having been on a white background, in percentages varying from 30 to 79. Those species showing the greatest modification of choice as a result of background adaptation are the straw-colored minnow, the silver-mouthed minnow, and the blackfin. The extent of the modification of their behavior ranges through 44 to 46 percent. Three intermediate species—the steel-colored minnow, the doughbelly, and the horned dace show percentage ranges through 25 to 31. The two species showing the smallest degree of choice are the orange-spotted sunfish and the blunt-nosed minnow, with ranges of 7 and 12 percent, respectively.

Comparisons of individual experiments on the straw-colored minnow suggest the possibility that the degree of modification of choice by background remains relatively constant and that the actual black and white percentages of choice may both move up and down the scale together.

It may be more than mere coincidence that those fishes (the straw-colored minnow, the silver-mouthed minnow, and the steel-colored minnow) with choices strongly influenced by their background adaptation, have a rate of color change appreciably more rapid than do fishes (sunfish, blunt-nosed minnow and doughbelly) the choices of which are influenced to a less extent. It is tempting to suspect that investigation of more species in this regard might confirm some rough correlation of this nature.

#### RATE OF CHANGE OF CHOICE WITH CHANGE OF BACKGROUND

The next experiments were designed to determine how rapidly fish change their behavior in response to change of background. In other words, how long must a black-adapted fish remain upon white before its measure of choice is changed from that characteristic of black background to that characteristic of white background, and vice versa. The silver-mouthed minnow was used in these experiments.

It has long been suspected, and the recent results of Parker and Brower demonstrate conclusively, that fishes, after long sojourn upon a black or white background, show somewhat slower melanophore response to change of background than is seen in fishes frequently changed from one background to another. To prevent the complications arising from a similar lag in rate of change of background choice with background change the fishes of this experiment were changed from black to white backgrounds and the reverse at intervals not exceeding one day, thus providing fishes with active melanophore systems. Nevertheless, it may be that some of the variability encountered in this experiment is due to lack of adequate control of these long-time effects.

In the first experiment fish that had been upon a black background for times ranging from 5 minutes to 3 hours were placed one at a time in the white adaptation pan in the apparatus and a stop-watch started. The moment the fish emerged into the choice pan the elapsed time and the choice were

recorded. The fish were not forced to leave the adaptation pan. For the longer time intervals the fish was held in the adaptation pan by temporarily blocking the exit. About a thousand trials with intervals in the white adaptation pan from 1 to 200 seconds gave a fair basis upon which to establish correlations between the length of time upon a background and the percentage response to black.

Table V shows the results of experiments of this sort, together with the number of fish going to black and white, grouped into convenient time intervals. It is obvious that with intervals up to four seconds upon white, much the same responses are obtained as among fishes coming directly from

TABLE V. SILVER-MOUTHED MINNOW

Exp. No.	Choice	Time Intervals on White after Black-adaptation							
		1-4 sec.	5-8 sec.	9-15 sec.	16-30 sec.	31-50 sec.	51-75 sec.	76-100 sec.	100-200 sec.
I	Bl.	30	22	9	14	5	14	4	1
	Wh.	6	3	11	11	11	14	12	13
II	Bl.	19	21	24	23	18	23	6	10
	Wh.	2	3	8	11	11	19	11	15
III	Bl.	15	17	9	21	25	19	11	5
	Wh.	3	7	12	18	25	18	5	4
IV	Bl.	32	28	30	35	17	17	16	17
	Wh.	10	12	10	11	23	23	24	23
Total		117	113	113	144	135	147	89	88
Black choices		96	88	72	93	65	73	37	33
Percent of black choices		82	78	64	65	48	50	42	38

TABLE VI. SILVER-MOUTHED MINNOW

Exp. No.	Choice	Time Intervals on Black after White-adaptation					
		1-4 sec.	5-8 sec.	9-15 sec.	16-30 sec.	31-50 sec.	51-75 sec.
I	Bl.	26	25	21	17	16	13
	Wh.	21	16	9	4	4	1
II	Bl.	20	29	15	16	10	9
	Wh.	12	21	9	8	5	5
III	Bl.	23	27	20	13	14	6
	Wh.	16	8	8	6	3	1
IV	Bl.	18	19	18	26	28	26
	Wh.	25	21	23	14	12	14
Total		161	166	123	104	92	75
Black choices		87	100	74	72	68	54
Percent of black choices		54	60	60	69	74	72

the black background. After one or two minutes the reactions are typical of fish adapted to white backgrounds for longer intervals of time. These results are plotted in Figure 3.

The reverse experiment of taking fish from a white background and placing them in a black-adaptation pan in the apparatus and then recording the time of emergence from this pan, together with the choice, gives information concerning the rate of change of behavior in the opposite direction. For this experiment a total of 721 trials were made. The results are assembled in Table VI. This change of behavior is also depicted in Figure 3.

DISCUSSION OF RESULTS

Although it is yet much too soon to enter upon a lengthy and general discussion of the effects of background adaptation upon modification of choice of background in fishes, we can nevertheless call attention to some interesting aspects of the results themselves and perhaps make suggestions with regard to some of the implications arising from them.

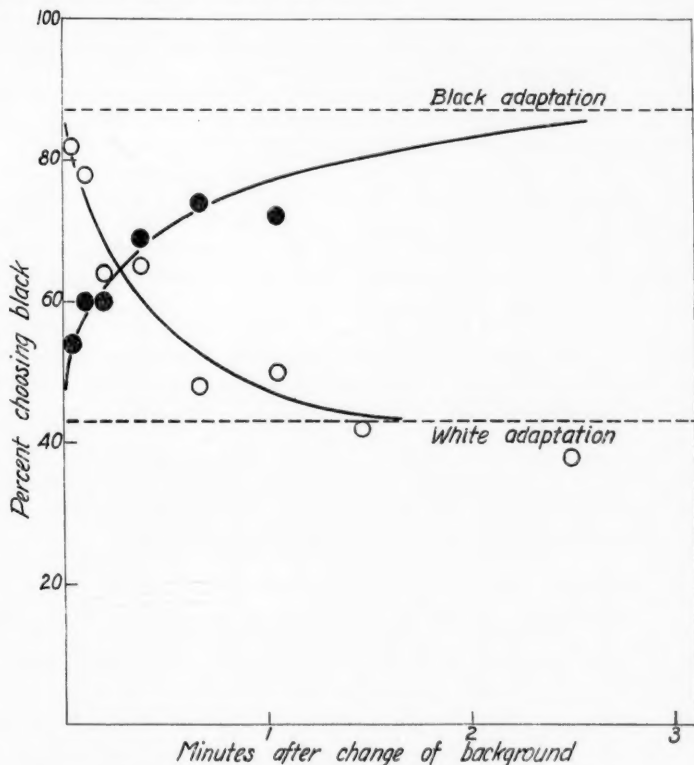


Figure 3. The rate of change of background choice in the silver-mouthed minnow following transfers from white to black (shaded circles) and from black to white (unshaded circles).

The fishes which show the greatest modification of background choice as a result of residence upon a black or a white background are the silver-mouthed minnow, the steel-colored minnow, the straw-colored minnow, and the black-fin. Interestingly enough, these are fishes which frequent shallow and relatively clear water in their natural habitat. Fishes like the orange-spotted sunfish and horned dace, which show a lesser degree of modification, are ones which characteristically hide a large part of the time. The remaining fishes, the blunt-nosed minnow and the doughbelly, which also show a relatively smaller degree of modification, are ones which have a more varied habit in this respect.



An interesting parallelism in background choice and melanophore response seems to exist. They have rates of change of the same order of magnitude in the one species that has been tested. The rate of change in diameter of the pigment mass is three or four times as great as the rate of change in background choice. The time for half change in the former is 4 to 6 seconds and in the latter between 15 and 20 seconds, upon transfer from a black to a white background.

The question of the usefulness to a fish of a modifiable background choice is, of course, intimately tied up with the problem of the protective nature of animal coloration in general. The latter subject has been in recent years a topic of much controversy. It seems reasonable to us, however, that such color adaptation must give some protection from predators and have an appreciable survival value in nature. The magnitude of the selective advantage of this behavior seems ample to insure that its inheritance will be maintained and perfected. The optimum rates of color change and choice change with respect to selective advantage would seem to be an interesting problem.

The problem of background selection was seen by Sumner in 1911 when he failed to obtain any positive results from a brief experiment he performed at that time. In 1935 he established the fact that color changes in fishes do have a protective value against seizure by birds, but he has apparently abandoned the notion that fishes might be modified in their behavior to select backgrounds to which their skin coloration is best adapted. He states, in speaking of some of the objections to the protective coloration hypothesis, "Animals which are well concealed on certain backgrounds do not restrict themselves to these backgrounds. Why should we expect them to? No adaptation . . . is ever perfect." Our results suggest that the background reaction system is a little more efficient than Sumner implied.

#### SUMMARY

1. The background choices of eight species of fresh-water fishes adapted to black and white backgrounds has been determined. The rate of change of choice upon change of background has been measured in the silver-mouthed minnow.
2. It has been found that fishes adapted to black backgrounds choose black more frequently than do fishes adapted to white backgrounds.
3. Black-adapted individuals of all of the eight species tested choose black more frequently than white-adapted individuals choose white.
4. The rate of change of background-choice in the silver-mouthed minnow following a change of background seems to be an orderly one which proceeds one-fourth to one-third as fast as the changes in skin color induced by similar background changes.

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## The Eggs of *Raja eglanteria* Bosc, With a Key to the Shells of New York Species

By C. M. BREDER, JR. AND J. T. NICHOLS

OF THE FOUR species of skates inhabiting the coastal waters of New York and New Jersey there is but one of which the eggs have not been clearly identified, i.e., *Raja eglanteria* Bosc. On June 14, 1934, a large female of that species was brought to the New York Aquarium from Sandy Hook Bay. The next day, June 15, it deposited two eggs and on June 18 two others. An attempt was made to hatch these eggs and as late as July 27 the developing embryos could be seen through the translucent shells when held to the light. By September 13 all were dead and the shells preserved.

The shells may be easily distinguished from those of the other local species chiefly on the basis of size and proportion, as indicated in the accompanying key.

Recently Vladykov (1936) has published an account of the egg capsules of Atlantic Canadian skates including *Raja senta* Garman, *R. radiata* Donovan, and *R. scabrata* Garman. His data compare well with the present. The only other elasmobranch capsules likely to be encountered on our coast are that of *Scyliorhinus* described and figured by Nichols (1931), which differs from all the skate eggs of the region by its long spirally twisted tendrils on all four corners, and that of *Raja granulata* Gill, as yet undescribed.

KEY TO THE EGG CASES OF NEW YORK SKATES, BASED CHIEFLY  
ON SHELL SIZE<sup>1</sup>

- A. Length of shell  $1\frac{1}{8}$  inches or less ( $1\frac{1}{2}$ — $1\frac{3}{4}$ ); width  $1\frac{1}{8}$  inches or under ( $\frac{7}{8}$  to  $1\frac{1}{8}$ ); prongs long, the longest longer than shell; width of shell in length 1.18 to 1.79 (32 specimens).....*R. erinacea*
- AA. Length of shell 2 inches or over; width  $1\frac{1}{8}$  inches or over
- B. Prongs long, the longest longer than shell, length of shell  $2\frac{1}{8}$  to  $2\frac{1}{4}$  inches; width of shell,  $1\frac{5}{8}$  to  $1\frac{3}{4}$  inches; width of shell in length 1.33 to 1.65 (7 specimens).....*R. diaphanes*
- BB. Prongs short, shorter than shell
- C. Length of shell 2 to  $3\frac{1}{4}$  inches; width of shell  $1\frac{5}{8}$  to  $2\frac{1}{4}$  inches; width of shell in length 1.22 to 1.89 (10 specimens).....*R. eglanteria*
- CC. Length of shell  $3\frac{1}{4}$  to  $5\frac{1}{4}$  inches; width of shell  $1\frac{7}{8}$  to  $2\frac{3}{4}$  inches; width of shell in length 2.00 to 2.35 (3 specimens).....*R. laevis*<sup>2</sup>

The *Raja eglanteria* eggs referred to above were a light amber at first, but darkened to a nearly dead black by the date of preservation. The shells of *R. erinacea* and *diaphanes*, as found cast up on beaches, are usually black, while those of the much larger *R. laevis* seen by us have always been light brown. The eggs of *R. eglanteria* here under discussion are shown in the accompanying photograph which was taken a few days after laying. The first two to the left, it will be noted, are somewhat more slender than the second two to the right. At the upper end, in each egg there is a transverse slot not noted by us in the eggs of other species. When the eggs were new this area was occupied by a transparent area of very thin and delicate shell which subsequently sloughed away to form a slot. In six cases identified with these, in the American Museum collection, this slot was not evident.

Perhaps the most interesting feature of these eggs is their method of anchorage. The anchor of each egg may be seen below it in the photograph. This consisted of a tangled skein of adhesive threads which form the heavy mass that holds the eggs in place by entangling grains of sand, bits of shell, etc. The origin of these structures seems to be in the four primarily very long and antennate prongs. The strain on these "anchor lines" after their entanglement in debris separates them along the edge of the shell nearly to its middle. The remaining prongs which form the basal and more substantial parts are then free from the anchoring lines and are shorter than the shell. Thus the egg is then attached to its anchor by four thin lines, two from each side of the shell. One of these may be seen distinctly in the photograph on the right side of the second egg from the left.

This method of attachment seems to be different from any described for elasmobranch eggs. At the same time there is suggested a uniform series, changing only in a quantitative sense for all those depositing squarish, four pronged eggs. These include all the skates (Raididae) and certain sharks (Scyliorhinidae). In the Scyliorhinidae the prongs are produced into four long spiral tendrils that tangle about submerged trash in a manner suggestive of the tendrils of certain vines. Kopsch (1897) described and illustrated this condition in *Scyllium canicula*.

The eggs of *Raja eglanteria* would seem to be similar to this except that

<sup>1</sup> Based on 52 exact measurements and other material. The figures of Bigelow and Welsh (1925) for *R. erinacea*, giving 2 by  $2\frac{1}{2}$  inches, are presumably typographical errors. The measurements of nine eggs of *R. eglanteria* from Florida (extralimital) suggest either a smaller southern race or an earlier maturity. These measurements are: length,  $1\frac{11}{16}$  to  $2\frac{1}{8}$  inches; width,  $1\frac{1}{4}$  to  $1\frac{1}{2}$ ; width of shell in length from 1.33 to 1.70.

<sup>2</sup> *R. stabuliforis* Garman.

the tendrils tear down along the sides, as previously described. The difference seems to be chiefly one of the relative strength of the various parts of the shell.

According to Daniels (1928), in certain of the skates (species unnamed) the prongs "serve as spikes to fix the developing egg in the weed or sand flats." Seal (1914) ascribed this mode of egg fixing to *Raja laevis*. The eggs he figures have no curving tendrils whatever, but only firm, practically straight spikes. The photograph in Vladykov shows practically no prongs.

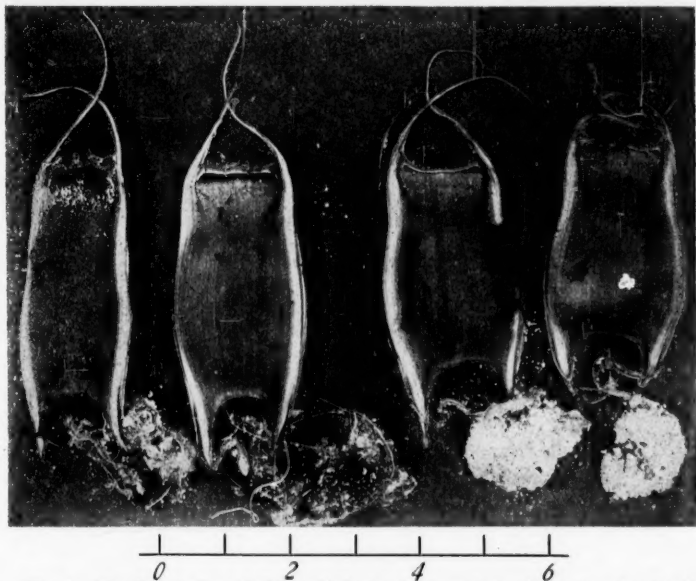


Fig. 1. The living eggs of *Raja eglanteria*. The product of one female; the two left hand eggs laid June 15, 1934, the two right hand eggs June 18, 1934. Scale in inches. Photo by S. C. Dunton.

Others, according to Norman (1931), are merely adhesive on one side and consequently are weighted down by adhesion to sand grains. In these the prongs would seem to have no particular function. Presumably it is *Raja maculata* Montagu that he refers to chiefly.

If these types of egg anchorage are arranged in a functional series with the simple, entangling tendrils of *Scyllium* at one end and the adhesive capsule of *Raja maculata* (in which the prongs no longer serve in anchorage) at the other, there are then two intermediates: *R. eglanteria*, in which the tendrils tear down to anchor the egg from the middle, and *R. laevis*, in which the tendrils only remain as spikes for impaling in the sand.

The egg of *R. erinacea*, with four barbless fish-hook like prongs, may drag about until they engage in some suitable entanglement, although such material as we have at hand shows remnants of some structure that is probably similar to the four line anchorage of the *R. eglanteria* egg.

The dates of egg laying of the four species compare as follows. Bigelow

and Welsh (1925) give from March to September for *R. erinacea* and Nichols and Breder (1926) May to October. The latter note eggs ready for release from *R. diaphanes* on December 20. *R. eglanteria*, as observed in this study, releases eggs in June, at least. *R. laevis*, according to Nichols and Breder (1926), apparently does not release its eggs in the New York region, but farther south.

The eggs of *Raja senta* discussed by Vladikov suggest the closest approach to those of *R. eglanteria*, as should, no doubt, be expected. The longitudinal striations are similar in appearance and the size and proportions are closely similar.

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AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

The Species and Its Subdivisions<sup>1</sup>

BY ISAAC GINSBURG

FISHERY biologists are greatly interested in the racial diversification of the species with which they work, for various reasons. Sometimes the question of specific differentiation becomes of importance in fishery investigations. Two categories in classification below the rank of genus or subgenus, namely, "species" and "race," generally seem to fulfill the needs of fishery investigators. Fish taxonomists usually also deal with two categories, which, however, they generally designate as "species" and "subspecies."

In other departments of biology we find that agronomists divide species of cultivated plants into categories which they most generally designate as "varieties." Botanists often make use of the terms "subspecies" and "variety" as categories of lower rank than full species. The term "variety" is in general use by botanists and zoologists, including ichthyologists. Anthropologists generally speak of populations of the genus *Homo* as "races." Other terms, such as "morpha," "natio," etc., have been proposed or are being used for

<sup>1</sup> Published by permission of the U. S. Commissioner of Fisheries.

various categories by some students of fishes as well as of other groups of living things.

Some biologists thus find it necessary to use several categories to express adequately the facts discovered. Others find one or two categories sufficient. Always these categories are the units which form the bases of biological discussions in general. Now, just what are the meanings of the terms "species," "subspecies," "race," etc.? Do they represent a play on words or do they have a meaning in the realities of life? It is evident that at the present time these terms are woefully lacking in definiteness. For instance, the same thing that one author calls a "species" may be referred to by another as a "subspecies." The terms "race" and "subspecies" are often used interchangeably. Not only the terms, but what is more important, the concepts that are meant to be expressed by these terms, also appear to be rather nebulous. In spite of the voluminous oral and written discussions which have been devoted to the species question, and classificatory categories in general, this fundamental and perennial problem in biology cannot be said to have been definitely solved yet. The problem, of course, is both biological and nomenclatorial. First, how are we to grade with a satisfactory measure of uniformity the various categories of specific or lower rank? Second, having graded them by biological methods, what nomenclature are we to apply to them, so that categories of approximately like rank will be universally denoted by the same term?

Fishery investigators have been indefatigable in pursuing their "racial" studies to which they devote a great deal of time and effort. The literature dealing with fishery investigations is replete with careful and constructive studies made by numerous earnest investigators in different countries. It may be well then to examine the essential nature of the problem, and see how it fits into the general scheme of biological studies.

The problem, of course, is not peculiar to fishes, and is of essentially the same nature for all groups of living things. It is fundamentally taxonomic in its nature. The questions of what is a species, or a subspecies, or a race, or any classificatory category of specific or lower rank, cannot be dissociated from one another. These categories are all reducible to one universal natural system. Each one of them essentially represents a variable population which varies within definitely circumscribed and circumscribable limits, and usually in a definite manner. This last statement may properly be used as a common, brief definition for the terms species, subspecies, race, etc. For the purpose of brevity in discussion, therefore, I use hereafter "population" as a general term to cover all these categories.

Natural populations are nearly always distinguished by differences in their morphology (an exception is discussed briefly below). This is the general method used by biologists for distinguishing populations of any rank. In order then to arrive at some definite conclusion regarding the meaning and status of the different categories in which populations are divided, it is well to lay aside for the time being purely speculative hypotheses regarding the probable manner in which populations originate in the process of evolution, and examine the sort of data actually obtained in practice, that form the basis of the criteria employed in determining the differences between and the status of natural populations.

Morphological population characters are roughly divisible into two kinds,

qualitative and quantitative. The latter class of characters is determinable with a comparatively high degree of precision, and is better adapted for the purpose of arriving at a definite conclusion in regard to this problem; but the former class may also be applied, and it is not necessary here to discuss in detail these two classes of characters. Two closely related populations usually differ in several characters. However, the differences between them in most characters is generally not pronounced. In practice, we usually employ those very few characters which show the greatest divergence, and very often only one character is available for the practical purpose of definite distinction of all or a majority of the individuals. Usually one character shows a greater degree of divergence than any other. In order to reduce the problem to its simplest terms we will confine ourselves mainly to the character showing the greatest divergence, or the chief distinguishing character. Now let us see how these characters occur in nature and how they are employed for distinguishing populations.

Population characters, of course, are variable, and in order to determine definitely the difference between any two closely related populations it is necessary to determine the range and manner of variation of the distinguishing characters for each one of the two populations. This gives a definite and comprehensive view of divergence between the two populations compared with respect to the characters investigated.

The variability of a population character, particularly if it is a quantitative character, may be represented with ease and precision in the form of a frequency distribution curve or histogram. Now, when we study carefully a number of pairs of closely related populations, construct the curves representing the chief distinguishing character for each population separately, and place them in pairs, in order, one below the other (or side by side), we get a series of pairs of curves showing an increasingly greater degree of intergradation somewhat like that in the accompanying diagram. This is a necessary consequence of the fact that pairs of related populations diverge in varying degree. It is evident that the greater the number of pairs of populations which we study, the more finely graded the series will be.

The diagram is a fair representation of the fundamental realities of speciation as they occur in nature. In any discussion cognizance must be taken of these fundamental facts, if it is to lead to any constructive and pertinent conclusions in the solution of the problem. In particular, we must not lose sight of the fact that we are dealing here with a series that is graduated by virtually infinitesimal steps.

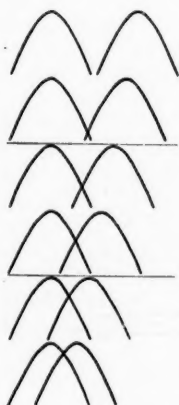
When the chief distinguishing character for a number of pairs of closely related populations is thus compared we find that sometimes there is a gap between the two populations. Every individual may be definitely referred, at least by the chief distinguishing character, either to one or to the other population. In such cases, probably all biologists will agree that the two populations belong to that category which is universally denoted by the term "species."

However, in nature such cases are in a minority. In the majority, the ranges of variability of even the chief distinguishing character overlap, and there is more or less intergradation between the two populations compared. This applies also to very many closely related populations which are now



generally recognized as of full specific rank by taxonomists. (Very probably it applies to the majority of what are now recognized as full species, after excluding species belonging to monotypic genera and subgenera.) To verify the preceding assertion it is only necessary to study in detail the pertinent characters of a sufficient number of specimens, generally a greater number than examined in the usual taxonomic practice. The rule that two closely related populations are to be considered of full specific rank only when there are no intergrades between them, breaks down when the actual facts of speciation as they occur in nature are carefully, intensively and extensively examined in detail. On the contrary, when a sufficient number of pairs of closely related populations, even of specific rank, are studied intensively it is found that, as a rule, they intergrade more or less.

In the accompanying diagram, there is no intergradation whatsoever between the pair of populations represented at the top of the series, and hardly



any biologist will question the propriety of regarding them as fully distinct species. Likewise, the two populations represented at the bottom of the series, which intergrade to a very high degree even in the character showing the greatest divergence, will not be recognized as fully distinct species by any biologist. In regard to the pairs of populations at the extreme ends general agreement with respect to specific assignment is to be expected. But in a gradual series such as we are dealing with, where is the line to be drawn between the species and categories of lesser rank, and if we find it desirable to have more than one of the lesser categories where are we to draw the line between them? Clearly, our concept of species, subspecies, race, etc., must be limited arbitrarily. In nature there are generally no sharp boundaries between the minor categories, and there is no fundamental difference between them. The difference between these categories is merely a matter of degree, and if we draw any lines

at all they must be arbitrary. For instance, we may draw arbitrary lines A and B in the diagram, and state that all pairs of populations, the divergence of which is of such a degree as to place them above line A, are to be regarded as fully distinct species, those below line B are to be regarded as races, and those between A and B as subspecies.

An attack of the problem from this point of view evidently points the way to its definite solution. Taxonomists in studying populations of living things were compelled by the facts discovered to devise, more or less intuitively, categories of varying degree, such as "species," "subspecies," etc., in accordance with the evident varying degrees of divergence or intergradation which the determined facts showed to exist between natural populations. The fact that taxonomists have found it necessary to use different categories, and the fact that they are so often employed, show that they serve a useful and convenient purpose in classification and the study of populations. However, our present day ideas about the limits of these categories and the meaning of the terms by which they are denoted, are hazy and are not used uniformly



in the same sense. By proceeding along the lines indicated each category may be fairly well delimited and invested with a fairly definite meaning. It may then be defined and the same term universally applied to any given category. The greater clarity, uniformity and definiteness thus introduced in the subject should prove to be of much help in the future study of populations.

For a final solution of the problem in the manner indicated two chief questions must be answered. First, it is necessary to express for practical purposes the facts represented by frequency distribution diagrams in terms of simple and easily determinable figures. In other words, we need to choose some appropriate and uniform measure of divergence or intergradation, for the purpose of expressing the precise degree of difference between any pair of populations. Second, it is necessary to decide what are the most appropriate lines to be drawn between the different categories by detailed, careful studies of a sufficient number of pairs of closely related populations to determine the different degrees of divergence as they occur in nature. During my studies of the populations of marine fishes, I have gathered data which I believe will solve these questions in a fairly satisfactory manner, at least one that is satisfactory from a practical, working point of view; but the presentation and analysis of the data and the conclusions to be drawn from them must be postponed now and will be taken up at some future time.

The crucial point that should be emphasized now is that the gradual series showing varying degrees of divergence as indicated partially in the accompanying diagram, is not merely theoretical. The curves in the diagram are, of course, theoretical and are presented merely for the purpose of illustration. In nature regular distributions as represented by the curves are seldom encountered. But, the existence of the series showing graduated degrees of divergence or intergradation is a fact which is susceptible of definite proof. It is only necessary to study adequate samples of a sufficient number of pairs of closely related populations, compare the data for any one pair diagrammatically, and arrange the pairs of diagrams in regular order. From the data gathered during my studies of the populations of fishes such a series is readily demonstrable. Judging by published data of various organisms scattered through the literature, there seems no doubt that such a series may be shown to exist in any group of living things.

The preceding discussion is based entirely on a study of morphological population characters. The hope is sometimes expressed by biologists of the ultimate development of a method for distinguishing species by physiological means. Some species of lower organisms have been so distinguished as so-called physiological species. However, we do know that physiological processes vary in a manner somewhat similar to variation in structure. Consequently, even if we ever do attain the hoped for ideal of distinguishing species—and other populations—by physiological means, the complexion of the problem as to the nature of the species, and its subdivisions, will very likely not be changed. Species and other populations will still have to be bounded according to the limits and manner of their variability. Looking at it from this point of view nothing will be gained by the substitution of physiological criteria, because physiological processes are less amenable to precise measurement and limitation than structure.

U. S. BUREAU OF FISHERIES, WASHINGTON, D. C.

## Ichthyological Notes

RECENT RECORDS EXTENDING THE RANGE OF *CAULOLATILUS MICROPS* NORTH OF FLORIDA.—While stationed at Wildwood, New Jersey, in connection with a mackerel investigation in the spring of 1931, I chanced upon a strange looking fish lying on the docks. On immediate inquiry I learned it had been caught in the trawl of the vessel *Caspian* about southeast of Cape Henry, Virginia, in about 45 fathoms of water on April 11. At the American Museum of Natural History, New York, I was able to identify the fish as a *Caulolatilus*, make a complete description of it and then preserve it in alcohol.

Because this specimen was doubtless a rather young one its characters did not check in detail with the *Caulolatilus microps* (Goode and Bean) as described by Jordan and Evermann and others. In fact it so closely resembled *C. chrysops*, *C. affinis*, *C. cyanops*, and *C. microps*, that Mr. J. T. Nichols and I at first questioned as to whether or not it should be described as a new species, especially since it was distinctly a new northern locality for this genus. After careful consideration, however, it was decided to store the fish away until perhaps another specimen should be discovered with which to compare this one.

One year later, in May, 1932, I received a letter from Mr. E. M. Burton, Director of the Charleston Museum, Charleston, South Carolina, in which he enclosed a photograph and description of a fish he had recently acquired from off Charleston, which he thought to belong to *Caulolatilus microps*. Although his specimen weighed thirteen pounds and measured twenty-nine inches, as compared with my pound and a half specimen measuring thirteen and a half inches, most of his description fitted mine, and these in turn combined to fit very nicely into Jordan and Evermann's description of *C. microps*. The range of this species having previously been reported around the Gulf of Mexico and Florida also fitted into the picture more closely than the Cuban and Brazilian ranges of *C. cyanops* and *C. chrysops*.

Thus feeling confident that the specimens were of *Caulolatilus microps* I was about to publish the new northerly range of the species when I came upon J. C. Pearson's paper *Winter trawl fishery off the Virginia and North Carolina coasts* (U.S. Bur. Fish. Pub. 4, Invest. Rep., 1, No. 10). In this paper Mr. Pearson listed 55 species observed in the trawl catch, among which was included a *Caulolatilus cyanops*, from off Currituck, North Carolina, trawled in 20 to 50 fathoms in April, 1931.

I wrote to Mr. Pearson asking for a loan of the specimen, which was generously granted. A careful check-up on its characters proved it to belong to *C. microps*. Mr. Pearson told me later that he had identified it only provisionally owing to lack of other material for comparison. It was smaller than either of the fish at hand, being approximately eleven inches long. Some of its characters were not identical with those of the slightly larger one I had found, probably because of age difference, but in the main it agreed beyond question with *C. microps*.

Thus there are three new northerly records for *C. microps* extending its known range from off Florida to Cape Henry, Virginia.

The distinguishing characteristics of *Caulolatilus microps* are scale counts and size of eye. In the larger specimens the body grows thicker and deeper. The color is fairly uniform, being a pale brownish shade, darker along the dorsal ridge, silvery on the ventral part. Pectoral fins are sharply pointed; eye small; one broad spine on the operculum. With increase in size and age the eye recedes from its early position over the end of the maxillary axis (in the young) to well behind this point (in the older ones). Scales are rough. The dorsal and anal fin counts are constant for all localities.

Goode and Bean first described this species in 1878 from off Florida (Proc. U.S. Nat. Mus., 1, 1878: 43). Since then records of its occurrence in coastal or offshore waters of the Middle and South Atlantic states have been very vague and scanty.

I wish to thank Mr. E. M. Burton and also Mr. J. C. Pearson for the use of their records and specimens.—F. E. FIRTH, U. S. Bureau of Fisheries, Biological Laboratories, Harvard University, Cambridge, Massachusetts.

## Herpetological Notes

SOME NOTES ON THE AMPHIBIA OF A WATERFOWL SANCTUARY, KALAMAZOO COUNTY, MICHIGAN.—The following observations were incidental to a study of birds and mammals at the W. K. Kellogg Bird Sanctuary and Farm (500 acres) in Kalamazoo County, Michigan, during 1935 and 1936. They are recorded here as a possible basis for comparison with other areas. Thanks are due to Dr. Miles D. Pirnie, Mr. Carl Gower and Mr. Curtis Bartlett for records and specimens.

Although the locality under observation includes Wintergreen Lake (21 acres), two marshy potholes, a long swale, and considerable woodland, it is interesting to note the almost complete absence of salamanders. Only one salamander has been recorded for this area in two years and their eggs at least were not noticed if they were present. One quarter-mile southwest, in Gull Lake, *Necturus maculosus* occurs in numbers. *Rana palustris* has not been found here, as might be expected from the absence of any flowing streams on the area. It is found in Augusta Creek a mile to the east. Comparatively few bullfrogs have been recorded although they are numerous in other lakes in the vicinity and are said to have been common in Wintergreen Lake before the establishment of the sanctuary in 1927. It is pertinent to mention that a large population of waterfowl (ducks and geese) is present on the lake during most of the year. Herons, bitterns and marsh hawks are present, though probably no more numerous than on other similar areas. There may be some connection between this and the scarcity of some of the above species.

*Ambystoma maculatum* Linnaeus.—Only one specimen of this animal has been taken. It was found in the grass near a swale on November 4, 1935. When placed in formalin it regurgitated earthworms. Searching under logs in the woods near a swale and in the other habitats has failed to produce any other specimens.

*Bufo americanus americanus* Holbrook.—In 1935 the earliest calls of this toad were heard on April 23. In 1936 the first singing came on April 24. In both seasons calling was intermittent until early May when a constant trill was heard from the swales and lakes margins. The singing continued in June and could be heard at times in July. Few animals are known to eat the toad. One such record was obtained on May 22, 1935, when the dismembered but undigested remains of a freshly killed toad were found in the stomach of a skunk (*Mephitis mephitis*).

*Bufo fowleri* Hinckley.—Fowler's toad began calling on May 8 in 1936. A specimen was taken on May 7. By May 22 a chorus could be heard every night. The calls were scattered and very loud, sometimes resembling the noise made by a flock of discontented sheep. Judging from calls and the few specimens examined, this toad is probably more common on the area than *B. americanus*. It was heard throughout June and commonly in July. The calls were most numerous along the shore of Wintergreen Lake and were heard often after *B. americanus* had stopped singing.

*Acris gryllus* (LeConte).—On this area the cricket frog began singing much later than *Pseudacris* or *Hyla crucifer*. On April 25, 1935, two were taken at the edge of the lake, although the first songs were not heard until about May 9 and the general chorus was not heard until May 23. In 1936 a specimen was captured on April 20. A few calls were heard on May 2 and became numerous on May 7. The species was in chorus all through early June. It tapered off late in that month but was heard at times in July. The actual last calls were not recorded. Cricket frogs were singing most abundantly in Wintergreen Lake. A few could be heard in the swales but the chorus was most noticeable in the spatterdock beds around the lake margin.

*Pseudacris triseriata* Wied.—The earliest spring record of *Pseudacris* is March 18, 1936, when a single individual was heard. The next record was March 24, when this species came suddenly into full chorus. In 1935 these frogs were in chorus before April 1. The singing of *Pseudacris* began to taper off in May and no general chorus was heard after June 1 in either 1935 or 1936. A few belated songs, however, occurred in unexpected places all during summer and fall. In 1935 several were heard on October 12 and the last record for the season was that of an individual singing in the edge of a grassy meadow on November 4. In 1936 Mr. Curtis Bartlett heard some calls during warm weather several days after Christmas that were undoubtedly this species. This frog, like *Hyla crucifer*, was found in the grassy swales but was not numerous in Wintergreen Lake proper. It is doubtless the most common amphibian on the area.

*Hyla crucifer* Wied.—“Peepers” were in full chorus on April 1, 1935 (no observations were made previous to this). The minimum temperature of the air on this date was 30° (all temperatures are Fahrenheit). The maximum for the day was 45°. On April 6, 7 and 8 the minimum temperatures were 29°, 28° and 29° respectively. During this period a strong wind prevailed from the northeast and few frogs were heard. On the 9th the minimum temperature was up to 33° and the frogs were again in full chorus. Generally speaking a strong wind or a minimum daily temperature below the freezing point tended to silence the frogs. However, usually a few were heard during the warm part of the day. The above temperature observations were equally true of *Pseudacris*. In the spring of 1936 the first peepers were heard on March 24. The minimum temperature on this date was the highest for the spring thus far, 51°. On the day before it had been 42°. This two-day warm spell followed a month during which the highest minimum daily temperature had never gone above 29°. *Hyla crucifer* could be heard on warm nights throughout April and early May. The last spring songs were heard about June 1 in the two years under discussion. This frog was found chiefly in the shallow swales, among the dead grass and sedges. A few were heard in the marshy borders of the lake but they were not numerous here in comparison.

*Hyla versicolor versicolor* LeConte.—The earliest spring records for the singing of this frog were May 15 in 1935 and May 2 in 1936. From these dates on several were heard occasionally in afternoon and night until a full chorus was reached in late May. The singing continued through early June and then became intermittent. Individuals were heard at times through the summer and the last record was September 20. A specimen was taken on a fence post far from woods or water on this date. The songs of these frogs came from the woods bordering the water. They could sometimes be seen through binoculars singing high up on the trunk of a tree. The actual breeding was not observed.

*Rana cantabrigensis* Baird.—The wood frog is not at all common on this area. It was found breeding in a pothole surrounded by buttonbush in the spring of 1936. A specimen was seen hopping toward the water and was captured on March 24. On the same day the clucking chorus began. The last calls were recorded on April 10. The pothole where these animals bred is two hundred yards from the nearest woods.

*Rana catesbeiana* Shaw.—This frog is not common at Wintergreen Lake. A specimen was seen in a swale on May 20, 1935, and in 1936 one was captured on May 6. This species was heard through June and July though at times the calling for days at a time seemed to be restricted to a single individual. The stomach of the above specimen contained an earthworm (*Lumbricus*), one *Rana pipiens*, several beetles of the families Dytiscidae, Hydrophilidae, and Scarabaeidae, and two water bugs of the family Belostomatidae.

*Rana clamitans* Latreille.—In 1935 the first calls of this frog were heard on May 28 and in 1936 on May 9. They were heard through June and July (last dates not noted). The calls were for the most part scattered around the border of the lake. Only a few were heard in the swales. They are not abundant here and no specimens were taken.

*Rana pipiens* Schreber.—The first leopard frogs were heard on March 28 in 1936. In 1935 singing had begun before April 1. Singing continued during April and May but the last dates were not noted. Considerable aggregations of these frogs occurred in the flooded swales where their eggs could be found in quantities.—DURWARD ALLEN, Kellogg Bird Sanctuary, Augusta, Michigan.

NOTE ON THE GROWTH RATE OF THE DESERT TORTOISE, *GOPHERUS AGASSIZI*.—During the spring months of 1931 a number of desert tortoises, *Gopherus agassizi* (Cooper), were collected on the Mojave Desert in the immediate vicinity of Lovejoy Springs, Los Angeles County, California. Twenty of these tortoises, varying in length from 75.5 mm. to 283.0 mm. were liberated near their place of capture on July 9, 1931. Two days prior to their liberation, each specimen was measured and marked with an aluminum tag stamped with a number. Measurements were made of the greatest width of the carapace, and the greatest length of the plastron including the gular extension in adult males.

During the next four years, only three of these tortoises were recaptured. The first was No. 11, a female of average size. Fifty-eight days after it was released it was located at the base of a precipitous butte, not more than 200 yards from the place of liberation.

At this time it was not measured but was left where it was found. Oddly enough, No. 11 was the first to be found again when on May 1, 1933, 619 days later, it was discovered at midday in the shade of a creosote bush on the opposite side of the butte, having traversed a minimum distance of 150 yards. The day following its capture it was returned to the laboratory and measured (680 days after the first measurement) when it was found to have grown 22 mm. in length and 13 mm. in width.

The second recovery was No. 5, a smaller female which by chance came into the possession of Dr. Loye Miller at the University of California at Los Angeles. It had been taken at Lovejoy Springs a few days previous to October 16, 1933, when it was measured. Over a period of 818 days it had gained 70 mm. in length and 48 mm. in width. Dr. Miller, who has published the most extensive study of the desert tortoise yet available<sup>1</sup> noted in captive specimens that there was much variation in growth rate and he immediately identified No. 5 as a fast growing individual. Measurements of the two follow:

No. 11	Length	250 mm.	Width	195 mm.	7/7/31
	Length	272 mm.	Width	208 mm.	5/1/33
Difference		22 mm.		13 mm.	680 days
No. 5	Length	150 mm.	Width	120 mm.	7/7/31
	Length	220 mm.	Width	168 mm.	10/16/33
Difference		70 mm.		40 mm.	818 days

The third tortoise to be recaptured was No. 16, an adult male, 287 mm. long and 215 mm. wide at the time of the measurement prior to liberation. When recaptured on May 30, 1935, after nearly four years of freedom, the width was unchanged, while measurement of the length disclosed a growth of only 7 mm., an increase probably to be attributed only to growth of the gular extension. This tortoise was found approximately three hundred yards from the spot where it was liberated in 1931.

Fair comparisons of these measurements of growth rate with those of Miller (1932: 198) are not easily made since Miller was able to examine laboratory animals at regular intervals of a year. Since growth takes place in the tortoise at seasonal intervals and probably not at all during hibernation, measurements made at desultory times when recapture permits cannot be compared accurately. The maximum observed by Miller for the increase in carapace length of captive specimens per year was 50 per cent, which compares favorably with an increase of 46.7 per cent for No. 5 over a period of 818 days, a period involving roughly one and one half growing seasons. Yet the greatest total growth for a three year period reported by Miller is 28.5 mm., far less than 70 mm., the growth for No. 5 over a period of 818 days; while No. 11, with a growth of 13 mm. in 680 days, exceeds the average total growth per year for Miller's laboratory animals which he assumed were kept under "conditions of food and water more favorable than their native habitat." His measurements were made upon young tortoises varying in size at capture from 50.4 to 123.2 mm., smaller than No. 5, which suggests that either the rate of growth is accelerated up to a certain size or age, or that Miller is wrong in his assumptions that "the growing period at Los Angeles is probably longer than it is on the desert," and that his observations on the growth "probably represent a somewhat greater than normal growth rate."—CHARLES M. BOGERT, *The American Museum of Natural History, New York City.*

**BLACK-BANDED SKINK IN IOWA.**—On February 15, 1937, W.P.A. workers uncovered a group of hibernating black-banded skinks (*Eumeces septentrionalis*) while digging in a refuse pile of a gravel pit southwest of Medium Lake in Palo Alto County, Iowa. The skinks were found beneath a ledge of yellow clay about four and one-half feet below the surface. The lizards, 52 in number, were assembled in a compact group about the size and shape of a football. A soft web-like material surrounded the mass and adhered to the bodies of the animals. Upon being uncovered some of them exhibited signs of life by slight movement; others were dead. Several of the skinks were taken to a heated room where they rapidly revived and became quite active.—THOS. G. SCOTT AND REUBEN B. SHIELDS, *Ames, Iowa.*

<sup>1</sup> Miller, Loye, Notes on the desert tortoise (*Testudo agassizii*). *Trans. San Diego Soc. Nat. Hist.*, (18), 1932: 187-208, pls. 10, 11.



## REVIEWS AND COMMENTS

**ANIMAL TREASURE.** By Ivan R. Sanderson. Viking Press, New York: 325 pp. 32 sketches in text.—When a popular book centers round the observations of an expedition, largely herpetological in scope, and the account is draped in a scientific cloak, it becomes of more than passing interest to professional zoologists. The more so, when such a book abounds in suggestions as to personnel, methods, criticisms of various kinds, theories based on superficial interpretation of observed data, and reproaches of those who perpetuate errors. On this last point the author professes so much concern that I hope he will not object to some of his own being pointed out at their source.

*Animal Treasure* is a popular account of an expedition to the Mamfe division, British Cameroons, where in less than eleven months Mr. Sanderson and his two companions secured about 1,200 amphibians and reptiles, 1,500 mammals, and 4,300 insects and other invertebrates. In addition the party obtained excellent photographs of the country and its fauna, together with valuable data on the coloration in life of the amphibia. Of outstanding interest was the discovery of two species of caecilians coiled about their eggs, one of the species being of an undescribed genus (*Idiocranium russeli* Parker).

To those who, like myself, have read Sanderson's interesting papers in the publications of the Royal Geographical Society, Linnean Society and Zoological Society of London, this book comes as a distinct disappointment. This is not because of its popular style—Mr. Sanderson writes well and with a sense of humor—but because of the obvious endeavor to extract the maximum sensation out of every incident, however trivial. Secondly, objection is taken to the sweeping generalizations, many of a biological nature.

Mr. Sanderson understands "why one expensive expedition after another was returning, having done little more than spend its money." He "even saw a reason for the endless repetition of false statements about the majority [sic] of animals." It is therefore of primary importance in selecting expedition personnel to consider carefully the applicants, of whom: "half will probably be zoologists. These must be eradicated without delay because there is nobody with less imagination or more hide-bound notions of procedure than the average young zoologist." From this we deduce that the author is not an average young zoologist, certainly none who reads his book will accuse him of lacking in imagination; but let him continue to state his opinion. He writes: "Upon this subject I hold views diametrically opposed to everybody else's, the medical world and people who have lived in the tropics not excluded. . . . For the tropics and hard work weed out all the athletes, sportsmen . . . select all those who are at least used to and at ease in smoky bars, airless cabarets, and crowded subway trains. . . . Last come questions of compatibility of temperament and similarity of tastes."

He considers that his views are justified by the results; whether his readers will be so impressed is doubtful, for references to illness in the party are frequent throughout the book.

How many persons will agree with this description of a virgin forest and its fauna? "One of the first laws revealed to us was the unsuspected fact that the life of the jungle is like that of the ocean floor. This has never been observed or remarked upon before. Everything drifts hither and thither as if wafted forward by currents and cross-currents. To stand still is to arouse suspicion, just as a diver, who can actually handle fish and other sea creatures provided he drifts with them across the bed of the sea, becomes an object to be feared and shunned as soon as he remains immobile and anchored. When hunting, we adopted two entirely different methods. George concealed himself at some vantage point and waited for the waves of forest life to drift by him; I drifted and eddied with the animals themselves. Doing this, I learnt many things and so did he. The speed at which I drifted, I found, must vary with the weather. Bright fine days brought life almost to a standstill. In a hurricane I had to run to keep pace with things."

Of the shrew (*Potamogale velox*) we read: "There is a fantastic animal, a veritable living fossil, that inhabits the mountain streams of West Africa . . . very little material

about it has been collected for study . . . nobody has been able to add to or subtract from the original descriptions by du Chaillu. This has led to the potamogale's becoming almost a zoological myth." Which statement must come as a distinct surprise to Messrs. Lang and Chapin who collected fifty-one specimens in the Congo two decades ago, which were extensively discussed by the late Dr. J. A. Allen.

For the skink (*Lygosoma fernandi*), a creature with an overall measurement of less than fifteen inches of which usually much more than half is tail, a surprising claim is made. Sanderson and his companions were returning to camp just as day was waning "when out of the stillness of the evening came that dreadful crescendo whistle." Two of the natives said that it had come from "the head of a long narrow valley ascending the mountain to their right." Sanderson and his companion thought that they "were exaggerating considerably in saying that it originated so far away." However, they set off, and after what was apparently quite a journey, "the valley narrowed to a ravine, the sound became gradually more piercing and as we still ascended, its volume increased to an extent that I had never believed possible; in fact, I had never met a louder sound caused by an animal. The whole air literally reverberated each time that it swelled forth. It might have been a really powerful fog-horn." The sound ceased, eventually they sat down in the fast gathering dusk, then "From beneath the very next clump of grass to that on which I was sitting that awful whistle began; but as I whisked round, it was cut short before reaching the peak of its crescendo."

Surrounding the clump, they found nothing but a steeply descending burrow in which they killed a skink. Sanderson continues: "So this was the phantom. No wonder nobody had ever suspected its true origin. Lizards are a silent group except for the geckos, and none other has ever been recorded that makes a noise like a fog-horn. Many have been disturbed, annoyed, almost driven mad by this noise in Africa; they will know what to hunt now."

Will they not rather be misled into slaying a perfectly harmless lizard through Sanderson's superficial deductions? After making due allowance for imaginative zoology, his description substantially coincides with the vibrant shrilling sound made at dusk by sturdy crickets, *Brachytrypetes membranaceus*, as they sit in the entrances of their burrows in rather dry grasslands. An airman has compared the noise emitted by one of these insects to that of a Gnome engine (c.f. Proc. Zool. Soc. London, 1923: 1036), and in districts where many crickets are calling simultaneously the noise assumes quite deafening proportions.

As we continue this amazing book, we read: "We captured six diurnal animals in Africa that belonged to groups all the other members of which are exclusively nocturnal. All six animals—a snake (*Gastropyxys senaragdina*) [sic], a squirrel (*Funisciurus poensis*), a monkey (*Cercopithecus pogonias*), a rat (*Oenomys hypoxanthus*), a flying squirrel (*Anomalurus beecrofti*), and finally, a lemur (*Galago demidovii*)—were bright green above and yellow beneath, whereas their near-related and nocturnal species were all of other colours." One hardly knows what to say about such utter nonsense. The snake alone answers to Sanderson's color description, the squirrel is olive above, yellow below, the rat has a slight greenish reflection on its fur anteriorly, but no yellow below. The monkey, scaly-tail and galago are neither green above nor yellow below except for a very slight yellow staining on the chin of the monkey. Through the courtesy of Dr. G. M. Allen I have been able to examine Cameroon examples of all these mammals. The groups to which the snake, squirrel and monkey belong are strictly diurnal, not nocturnal. As to Sanderson's statement that the rat, scaly-tail and galago are diurnal, I very much doubt it. If an individual occasionally suns itself outside its retreat during cold weather or at sunrise, the action is insufficient justification for labeling the species diurnal.

A native was bitten by a snake that he had brought in. The victim remained unconcerned and calm, not so Sanderson. He reports: "I then cut a very considerable piece of his thumb off and rubbed raw permanganate of potash crystals into the wound." (Why "raw" crystals?) With a wealth of dramatic detail the tale continues to its climax. As the snake was preserved it may be fairly assumed that Sanderson knew its name when writing. The suspicion is thus roused that it is withheld because it was the perfectly harmless colubrine *Bothrophthalmus lineatus*, as would appear from the description. Was it feared that unimaginative facts might spoil a good story?—ARTHUR LOVERIDGE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*



**RIVER MANAGEMENT.** By H. E. Towner Coston, F. T. K. Pentelow, and R. W. Butcher. Seeley, Service & Co. Ltd., London, England, 1936: 1-263, illustr.—“The Making, Care and Development of Salmon and Trout Rivers” is the subtitle of this book, which is professedly written for anglers and fishery owners or managers.

Discussion of the natural food of trout and how it may be increased is followed by a consideration of the characteristics of good trout water. It is interesting to note that temperature, often a limiting factor in America, is not mentioned, whereas oxygen deficiencies, which are rare in our trout streams, receive primary attention—a reflection of the climate and stream character in the two countries. Various problems such as weeds, mud, predators and competitors, pollution, etc., are then treated in considerable detail. The relative value of stocking trout of various ages—from eyed ova to 3-year fish is discussed but no proof of the value of any method is given. Planting procedure and the problems attending hatching and rearing trout are dealt with in a general way. The book concludes with a discussion of the life history of the Atlantic salmon and methods for improving salmon waters.

The authors are apparently familiar with American aquicultural literature but have gained a number of erroneous ideas such as: that Shasta rainbow trout are autumn spawners; that “after numberless experiments they (American fishculturists) have found that the most practicable and economical method of stocking is with fish twelve inches and up”!

In contrast to the popular faith expressed in trout propagation the authors doubt the value of artificially stocking salmon. They suggest that “many of the streams are probably fully stocked by nature so that any artificial increase of the population is wasteful.”

The large and well illustrated chapter on aquatic plants with an artificial key to the common species appears to be authoritative and should be very useful to fishery managers. In fact the entire text should be easily understandable and contains much sound biology which may be the more acceptable to the public for the inclusion of much that agrees with popular opinion even though unverified by scientific fact.—ALBERT S. HAZZARD, *Institute for Fisheries Research, University of Michigan, Ann Arbor, Michigan.*

**THE NATION'S SEA-FISH SUPPLY, THE BUCKLAND LECTURES FOR 1936.** By E. Ford. Edward Arnold and Co., London, 1937: 112 pp., 8 figs., 3 pls. Price, 3/6.—The passing by the British Parliament of the Sea-Fishing Industry Act of 1933 marked the end of an era of unrestricted British high seas fishing. In the Buckland Lectures for 1936 the author describes the critical condition in the British fisheries that made necessary this abandonment of a traditional *laissez faire* policy. He also discusses in non-technical language the scientific observations and experiments that led up to the present regulations.

Two regulations, restriction of foreign landings and cessation of far north fishing during the summer, were designed to ameliorate the state of overproduction engulfing the industry. The latter condition resulted from the loss of foreign markets and from competition with other foodstuffs at home. Summer restriction of far north fishing also eliminated the large quantities of fish in poor or questionable condition landed from distant grounds during the hot weather months. Two other regulations, adoption of a minimum mesh size and minimum fish size were designed to reduce the very extensive destruction of undersized fish, which was an important factor in decimating the commercial fish population in the North Sea and other nearby waters. The author describes the mesh experiments of Davis and others which had proved that these latter measures would provide positive results.

The Sea-Fishing Industry Act also provided for a Sea Fish Commission to investigate the whole fishing industry from the sea to the consumer and to advise the Government as to what steps, if any, ought to be taken for the reorganization of the industry. This commission has prepared reports and recommendations covering the herring and whitefish industries.

The Buckland Lectures for 1936 should be of interest to those concerned with the problems of the commercial fisheries. They sum up the general situation of the fishing industry in Great Britain and the scientific background for the measures that have been adopted to improve it.—WM. C. HERRINGTON, *U.S. Bureau of Fisheries, Cambridge, Massachusetts.*

**TIGERS OF THE SEA.** By Col. Hugh D. Wise. The Derrydale Press, New York, 1937: i-xvi, 1-189; plates. \$10.00.—Big game anglers usually steer clear of sharks, partly because those fishes do not frequently take a trolled lure, partly because they often attack other fishes that are being played, and partly, perhaps chiefly, because of the general prejudice against Elasmobranchs.

For several years Colonel Wise has experimented with methods of shark fishing, and in his book gives directions for taking these fishes with rod and reel. Why anglers have not thought of such methods already I do not know; certainly they have been missing a most exciting sport. The book is written in entertaining and clear style, has a more than usual respect for scientific niceties, is well illustrated with original action pictures of shark fishing as well as with reproduction from Garman and other sources. The format and typography are beautiful.—LIONEL A. WALFORD, *Bureau of Fisheries, Washington, D.C.*

**AN AMERICAN ANGLER IN AUSTRALIA.** By Zane Grey. Harper and Brothers, New York and London, 1937, vi, 1-115, 35 pls. \$2.50.—Zane Grey does considerable traveling about the world, angling for big game fishes. What a lot could be gained from all this activity if he would only bring back some specimens of his victims for museums, and what a lot Mr. Grey might learn if he took a competent ichthyologist along with him! In the present work he says, "I have located broadbill swordfish, the genuine *Ziphius gladius* (sic), in the shallow waters of the Gulf of Carpentaria, spawning on the white sand, as thick as fence pickets!" He lands among other things a California yellow-tail, *Cereola dorsalis* (sic) in Australia, and the first "green thresher fox shark" ever known to be caught. You cannot help wishing you had been there to see what really was caught.—L. A. WALFORD, *U.S. Bureau of Fisheries, Washington, D.C.*

**ANGLING SUCCESS.** By Leading Outdoor Writers, Edited by Mortimer Norton. Macmillan Co., New York, 1935: xxii, 291 pp. 44 figs. \$2.50.—Here are 16 chapters, each discussing the angling lore of a different species of fresh water fish, and written by a well-known sports writer. Each chapter is accompanied by a brief biography of its author. The book accomplishes what it starts out to do—tells the angler when, where, and how to fish, and tells it with a minimum of gush. The book is well illustrated with photographs.—TALBOTT DENMEAD, *U.S. Bureau of Fisheries, Washington, D.C.*

**MODERN SEA FISHING FROM BASS TO TUNNY.** By Eric Cooper. A. & C. Black Ltd., London, 1937: ix, 1-238, several plates. \$2.50.—This book treats with North Sea fishes like cod, pollack, flounders, mackerel, etc., and therefore would be of more interest to anglers along our North Atlantic coast than elsewhere in America. There is an interesting chapter devoted to tunny fishing in the British Isles, though nothing new to us is offered on technique. Mr. Cooper says that silk fishing lines will outlast linen in salt water usage, a most unorthodox statement, and certainly worth testing by American anglers.—T. DENMEAD, *U. S. Bureau of Fisheries, Washington, D.C.*

#### RECENT BOOKS RECEIVED

**BIOLOGICAL TIME.** By P. Lecomte du Nouÿ. Macmillan Co., New York, 1937: xiv, 1-177, 31 figs. \$2.00.

**THE MAKING OF A SCIENTIST.** By Raymond L. Ditmars. Macmillan Co., New York, 1937: xii, 1-258, 23 pls. \$2.75.

**DIE ERHALTUNG UND PFLEGE DER FISCHGEWÄSSER.** By Ernst Röhler. Handbuch der Binnenfischerei Mitteleuropas, edited by R. Demoll and H. N. Maier, Band VI, Lieferung 4, Stuttgart, 1937; pp. 343-416, 59 text figs. plates 5-15. Price, RM.9.75.

**MODERN COARSE FISHING.** By H. D. Turing. A. & C. Black, Ltd., London, 1937: xii, 1-240, several figs. \$2.50.

**FISH AND FIND OUT.** By Major R. C. Simpson. A. & C. Black, Ltd., London, 1937: xii, 1-220. \$7.00.

## EDITORIAL NOTES AND NEWS



Photograph furnished by William K. Gregory.

### David Watson

**D**AVID MEREDITH SEARES WATSON, F.R.S., M.Sc., F.Z.S., Jodrell Professor of Zoology and Comparative Anatomy, University College, London, was elected to honorary membership at the last annual meeting of the American Society of Ichthyologists and Herpetologists in recognition of his outstanding contributions to the knowledge of the evolution and major classification of the vertebrates. A man of surpassing brilliance, originality and versatility, he has dealt successfully with such diverse problems as the mechanics and methods of flight among pterodactyls, the properties of materials entering into the construction of airplanes, the direction of research and the planning of new laboratories for the Royal College of Veterinaries, the succession of vertebrate faunas in the Karroo system of South Africa, the morphology of the extinct mammal-like reptiles, and many others. Perhaps his greatest work is the Memoir on the Acanthodians (now in press), in which he establishes for the reception of these Paleozoic fishes a new class, standing near the base of the vertebrates.—W. K. GREGORY.

### Leonhard Stejneger

**A** DELIGHTFUL dinner was held in honor of Dr. LEONHARD STEJNEGER, head curator of biology, United States National Museum, Saturday evening, October 30, 1937, at the Cosmos Club, Washington, D.C. The occasion, at which over a hundred friends assembled, was the celebration of his eighty-sixth birthday. Dr. Charles G. Abbot, Secretary of the Smith-

sonian Institution, presided, and while the numerous courses were being served he called for the reading of several of the congratulatory letters sent in by over sixty scientists living in foreign countries. About two hundred similar letters were received from Dr. Stejneger's scientific friends in North America. These will be bound in a volume and presented to him.

Dr. Stejneger's inspiration to his friends, broad vision, and kindly encouragement to his colleagues, and his own contributions which set a standard for careful scientific research were mentioned in addresses, by His Excellency Wilhelm Munthe Morgenstierne, Norwegian Minister to the United States; Dr. Alexander Wetmore, Assistant Secretary of the U.S. National Museum (read by Dr. Friedman); Dr. Albert H. Wright, professor of Zoology, Cornell University; Dr. William Mann, Director of the National Zoological Park; Dr. Charles W. Stiles, formerly of the U.S. Public Health Service; and Dr. A. K. Fisher, formerly of the U.S. Biological Survey. Dr. C. Hart Merriam, the first chief of the U.S. Biological Survey, gave a short personal account of Dr. Stejneger's first trip to the Grand Canyon in Arizona.

Dr. Hugh M. Smith was responsible for the preparation of a beautifully printed program and menu for the dinner. It was one of the most unique features of the occasion. On the inside cover was a portrait of Dr. Stejneger, a reproduction from the painting in the National Gallery of Art. The numerous outstanding events of his life and the honors bestowed upon Dr. Stejneger were printed, along with a list of four mammals, ten birds, fifteen reptiles and amphibians, four fishes, five invertebrates, and one plant, all named in his honor. On other pages occurred several pictures of the animals named after Dr. Stejneger, one of which, *Sphaerodactylus stejnegeri* Cochran, had never before been figured. On the inside of the back cover was a picture of a hair seal from a water color drawing made by Dr. Stejneger while on Bering Island in 1882.

At the close of the dinner Dr. Stejneger gave a short and very appropriate response to the various addresses delivered in his honor.—LEONARD P. SCHULTZ.

#### Meeting of the Western Division

THE ninth annual meeting of the WESTERN DIVISION of the American Society of Ichthyologists and Herpetologists was held in Denver, Colorado, on June 22, with about 40 members and visitors in attendance. THE DIVISION was especially honored by the presence of Dr. WILLIAM E. RITTER, Honorary President of Science Service.

At 9 A.M. the meeting was called to order by President ROLF L. BOLIN, who, in the absence of the acting secretary, GEORGE S. MYERS, appointed LEO SHAPOVALOV to this position for the duration of the meeting.

The following papers were read and discussed:

1. The Relative Numbers of Species of Marine Fish on the Louisiana Coast.—Gordon Gunter.
2. The Anatomy and Distribution of the Spinal Nerves of Snakes.—Walter Mosauer and Edna Caney. Read by D. M. Allen.
3. Types of Plagiostome Hypophysis.—H. W. Norris.
4. The Fossil Amphibian Fauna of the Middle Pliocene of Kansas.—Edward H. Taylor.
5. Types of Evolution Expressed by the Cottid Fishes.—Rolf L. Bolin.
6. Frogs of the *Hyla eximia* Group with Descriptions of New Species.—Edward H. Taylor.
7. The Scales of Polypterus and Lepisosteus Compared.—T. D. A. Cockerell.
8. Lizards in Insect Control.—George F. Knowlton.
9. Migrations of Fishes and Amphibians in a California Coastal Stream.—Leo Shapovalov.
10. Motion Pictures of the Feeding of the Western Diamond Rattlesnake.—Chas. T. Vorhies.
11. Progress in the Location of Rattlesnake Dens.—A. W. Woodbury.

President BOLIN read DR. WALTER MOSAUER's tribute to and review of the scientific career of DR. FRANZ WERNER, noted herpetologist and emeritus professor of zoology at the University of Vienna.

The following officers were elected for the coming year: President, MAJOR CHAPMAN GRANT, San Diego, California; Vice President, DR. CHARLES E. BURT, Winfield, Kansas; Secretary-Treasurer, MISS MARGARET STOREY, Stanford University, California.

**Endowment  
Fund**

ON APRIL 1, 1937, PRESIDENT GREGORY sent a letter to all members of our Society requesting contributions to an Endowment Fund for COPEIA. A small number of members responded in a most generous fashion and within a relatively short period the Treasurer was able to deposit almost four hundred dollars in a special savings account. The officers hoped that small contributions would continue to arrive but recent months have witnessed no additions to the Fund. We now make an especial plea that all members who can do so, become Life Members by paying three annual installments of \$25.00 each, or the full amount (\$75.00) at one time. All moneys so received will be placed in the Endowment Fund and will begin accumulating interest immediately. The Society now has three Life Members, Dr. Thomas Barbour, Dr. Carl L. Hubbs, and Mrs. Helen T. Gaige, but a membership of over 500 should include many persons able and willing to help the Society in this fashion while relieving themselves of the yearly bother of paying dues. When the Endowment Fund reaches sufficient size the income will be used for the publication of longer articles than are now possible, for additional illustrations, and for the further general improvement of COPEIA.

**Expedition  
Notes**

KARL P. SCHMIDT and D. DWIGHT DAVIS, of the Field Museum, were joined by WALTER NECKER, of the Chicago Academy of Sciences, in herpetological work on the Big Bend region in western Texas in July and August. The project for a national park in this region is of especial interest to naturalists as offering a great field laboratory for the study of the interaction of mountain and desert: its importance is enhanced by the offer of the Mexican government to set aside an equal area on the Mexican side of the Rio Grande.

DR. ALBERT W. HERRE, of Stanford University, has recently returned from his latest oriental expedition with large collections from Japan, China, the Philippines, British North Borneo, Sarawak, the Malay Peninsula, Penang, the Irawaddy Delta, and Bengal. While in Singapore and Calcutta he made arrangements to work over parts of the collections of the Raffles and Indian Museums.

**News  
Items**

DR. JACQUES PELLEGRIN, distinguished French ichthyologist, has been named head professor of zoology (reptiles and fishes) in the Museum d'Histoire Naturelle, Paris, succeeding DR. LOUIS ROULE, who has retired.

DR. ROLF BOLIN, of the Hopkins Marine Station of Stanford University, is working on California lantern fishes and on the extensive Brazilian and Paraguayan collections of the Field Museum.

FRANK JOBES, of the U. S. Bureau of Fisheries, has been transferred back to Ann Arbor, where he hopes to continue his former research on the life history of the perch of the Great Lakes.

MISS MARGARET STOREY, of the Natural History Museum of Stanford University, is currently engaged in a revision of the West Indian clupeid fishes of the genus *Harengula*.

MR. GORDON GUNTER, formerly of the Texas Oyster Development Corporation, has taken the position of zoologist with the Matagorda Bay Oyster Farms, Inc., of Matagorda, Texas.

The U. S. BUREAU OF FISHERIES is beginning two major fishery investigations, one on the shad along the Atlantic coast, with ROBERT A. NESBIT in charge, the other on the Pacific sardine, under the direction of O. E. SETTE and LIONEL A. WOLFORD, with headquarters at Stanford University.

DR. A. F. CARR, JR., has been appointed instructor in zoology at the University of Florida.

DR. CHARLES M. BREDER, JR. has been appointed acting director of the New York Aquarium in place of DR. CHARLES H. TOWNSEND, who retired November 1, after thirty-five years of service.

**Recent  
Deaths**

**D**OCTOR LOUIS PIERRE GILTAY, distinguished Belgian ichthyologist, died on January 27, 1937. He was Professor at the Free University of Brussels, Curator at the Royal Museum of Natural History, and President of the Belgian Section of the International Committee for the Protection of Birds.

We regret to report the death of DR. HUGH D. REED, head of the Department of Zoology, Cornell University. Dr. Reed is known to us particularly for his work on the poison glands and fin structures of catfishes, and also for his studies on the vertebrates of the Cayuga Lake Basin.

DR. WILL SCOTT, Professor of Zoology, and Director of the Biological Station of Indiana University, died on October 17. Dr. Scott was well known for his work on the limnology and the biology of the fishes of Indiana lakes, and trained a number of the present workers in fisheries research.

F. W. URICH, long known for his interest in the natural history of Trinidad, and especially for his studies on the herpetological fauna, died in August of this year.

FRANK STEPHENS, pioneer west coast biologist, and the first Director of the San Diego Natural History Museum, died on October 5, at the age of 89. Mr. Stephens was probably most widely known as an ornithologist, but he was also an ardent field naturalist, of broad interests, with a comprehensive knowledge of the mammal, bird, and reptile-amphibian fauna of southern California.

We have recently learned of the death in 1936 of MR. DEV DEV MUKERJI, assistant in the Zoological Survey of India, Calcutta. His death at the early age of 34 cut short a promising career in ichthyological research.

**Microhylidae  
versus  
Brevicipitidae**

**A**T the request of a member of the Society the standing Committee on Nomenclature is considering the question of Microhylidae vs Brevicipitidae. The two opposite opinions may be found in Parker's *Monograph of the Frogs of the Family Microhylidae*, pp. 15-16, and in Dunn's review of his work (COPEIA, 1935: 109). Members who are interested in this question are asked to send a statement of their opinion to the SECRETARY for transmittal to the Committee.

**A Gift  
Suggestion**

**T**HE EDITORS wish to suggest that a partial or complete back file of COPEIA would make a very acceptable gift for an ichthyological or herpetological friend. Complete sets of the old series (Nos. 1 to 173, 1913 to 1929, with indices) may be had for \$35.00; Nos. 1 to 51, 1913 to 1917, with indices, for \$10.27; Nos. 1 to 51, 1913 to 1917, with index, for \$4.00. A detailed price-list may be obtained from the editors.

**Aid to  
Copeia**

**F**INANCIAL aid in the publishing of this issue of COPEIA has been received from the American Wildlife Institute, J. T. Nichols, C. M. Breder, Jr., and Helen T. Gaige.

**Corrections**

**I**N COPEIA, No. 2, 1937, in the article "The Growth of the Large Mouthed Black Bass, *Huro salmoides* (Lacépède), in the Waters of Wisconsin," by George W. Bennett, pp. 104-118. Figures 4 and 5 are transposed. In "A New Species of *Rhadinaea* from San Luis Potosi," by Joseph R. Bailey, pp. 118-119, owing to a transposition of type in the manuscript, the paratype numbers of *Rhadinaea gaigeae* given as M. C. Z. 24892, 24894-5, 4359 should read 24982, 24984-85, and 4539.

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